

Demystifying Medicine Lecture Series

Scientific Discovery and Malaria Interventions for Global Health

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Bethesda, MD

The Millennium Development Goals (MDGs)

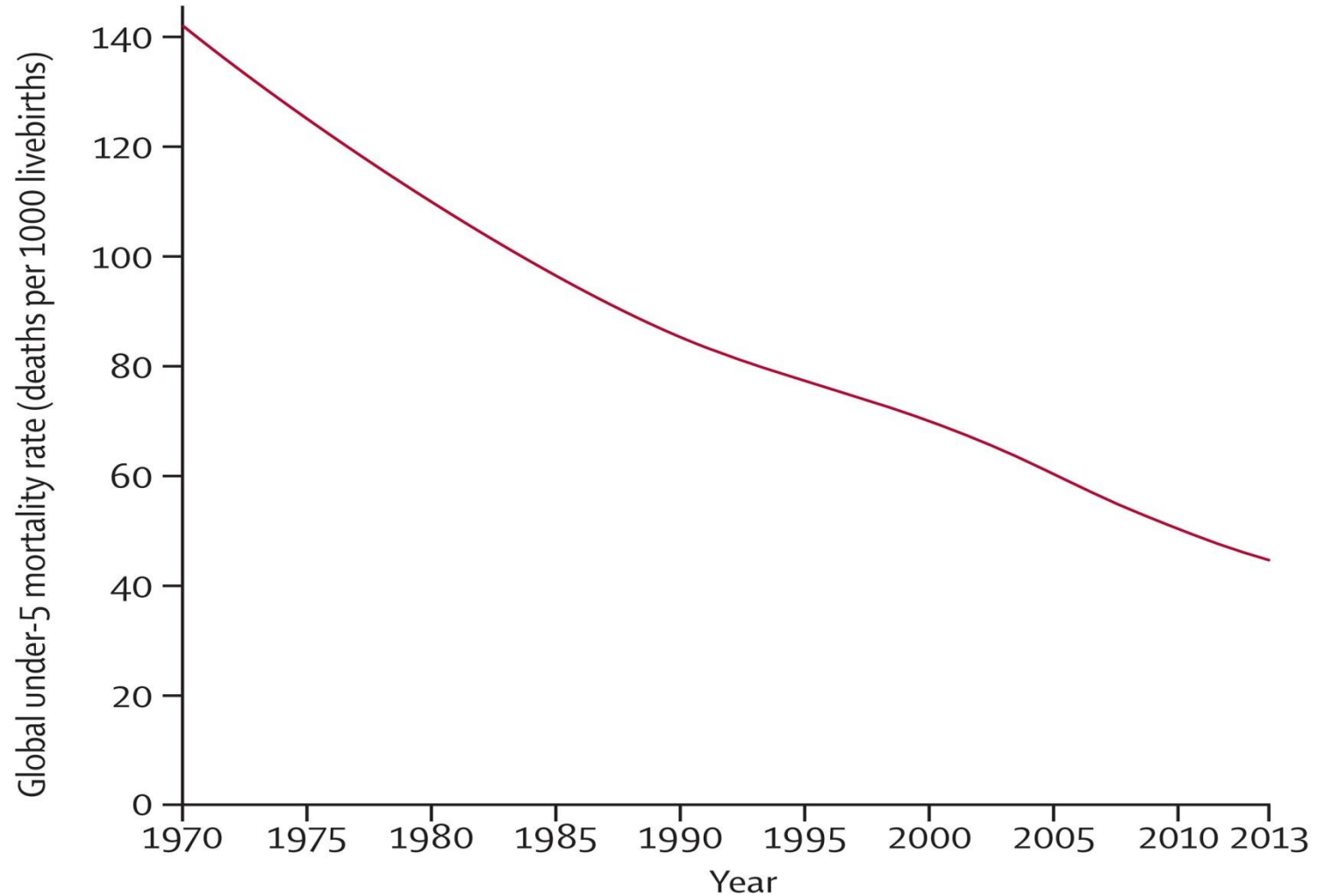
At the United Nations Millennium Summit in September 2000, world leaders committed to work together to mobilize the energy and capacity of the international community, to meet a series of targets to reduce poverty and inequality and named these the Millennium Development Goals (MDGs). The goals are to:

1. **Eradicate extreme poverty and hunger**
2. **Achieve universal primary education**
3. **Promote gender equality and empower women**
4. **Reduce child mortality**
5. **Improve maternal health**
6. **Combat HIV/AIDS, malaria, and other diseases**
7. **Ensure environmental sustainability**
8. **Develop a global partnership for development**



These goals are linked to measurable targets, such as cutting in half the proportion of people living in extreme poverty, halving the proportion of people without access to safe drinking water, and reducing by two thirds the mortality rate of children under five - all by 2015.

Global Under-5 Mortality Rate, 1970-2013

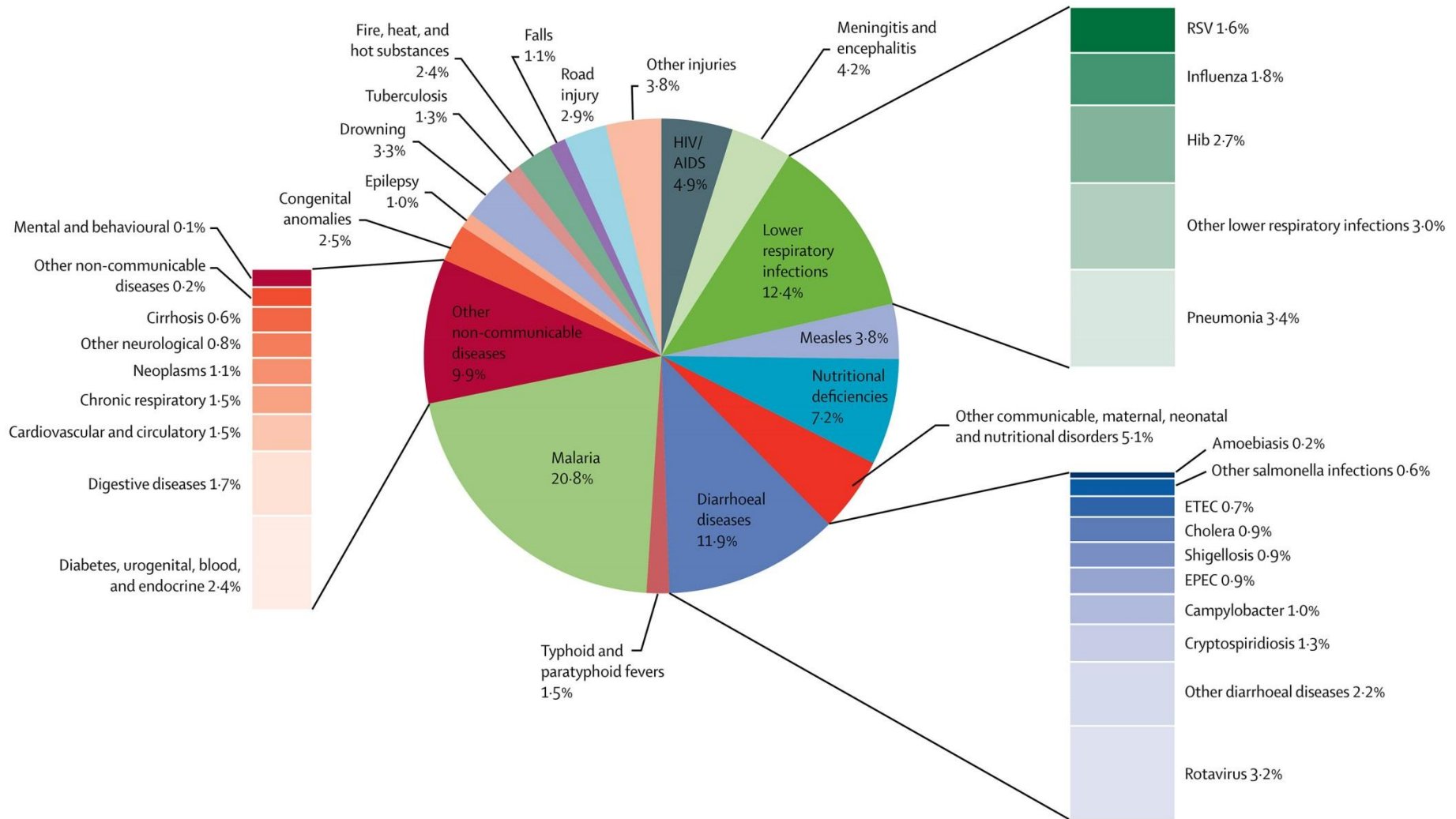


Contributions to Change in Under-5 Deaths, 1990 vs. 2013

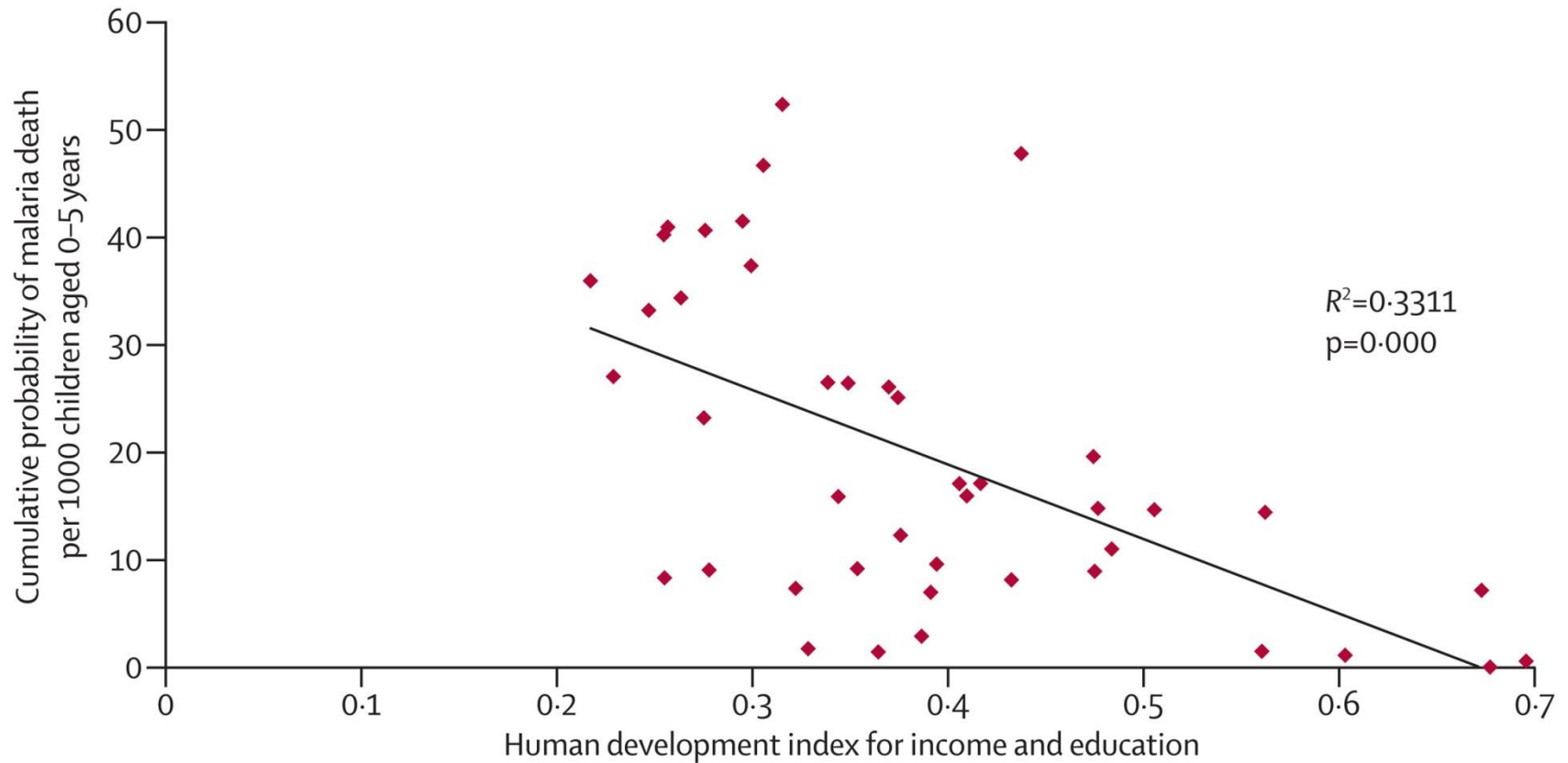
Factor	Change in Deaths (thousands)	Contribution
Fertility	1,424	+24.6%
Maternal education	-2,224	-38.5%
Income	-902	-15.6%
Secular trend*	-4170	-72.1%
Unexplained	+58	+1.0%
HIV/AIDS	+32	+0.6%
<i>TOTAL</i>	<i>-5782</i>	

* Secular trend includes: development assistance for health initiatives, health care system and public health policy improvements, new technologies (vaccines, drugs, ITNs, diagnostics)

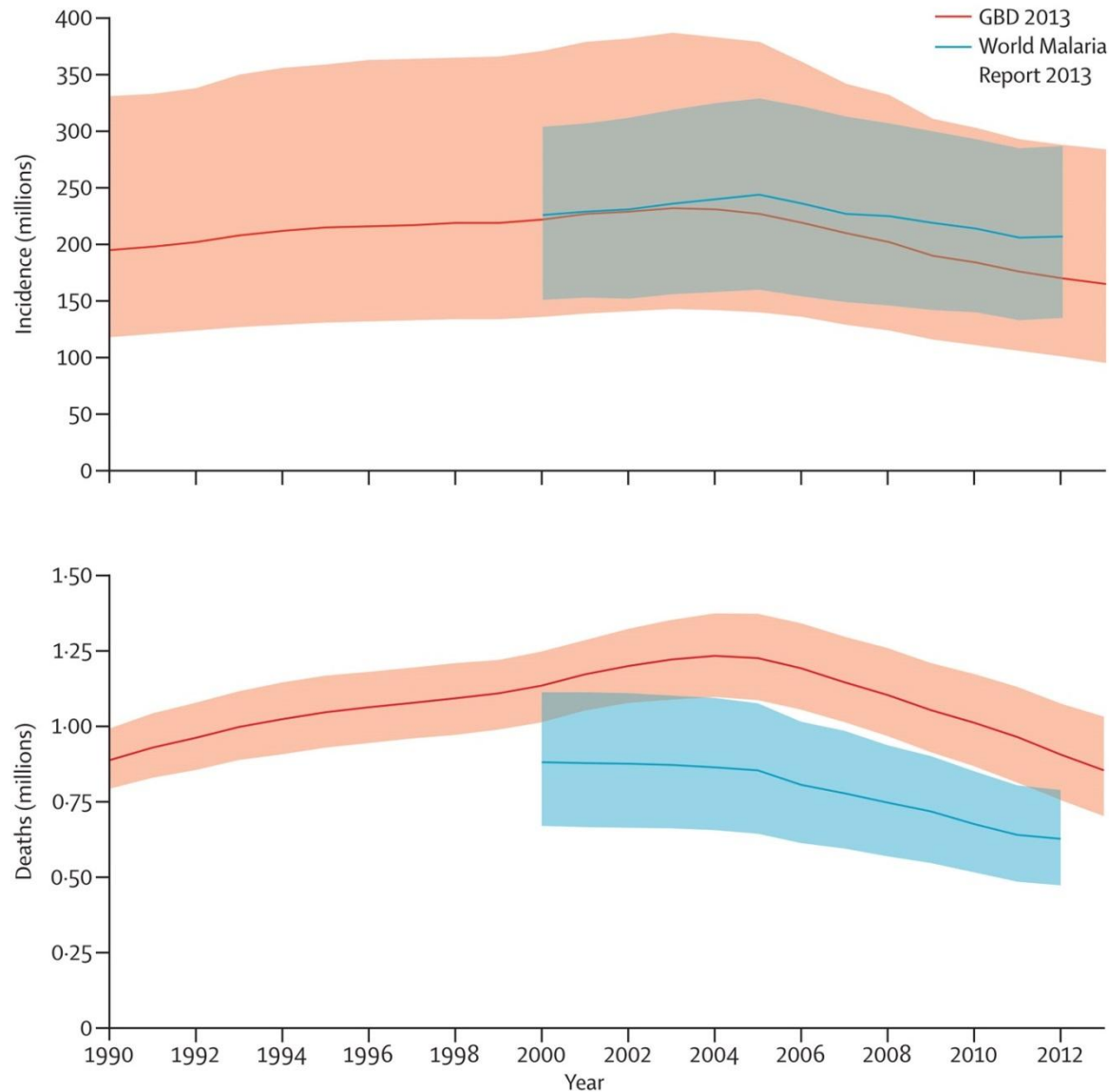
Global Causes of Deaths in 1-4 y/o Children (2010)



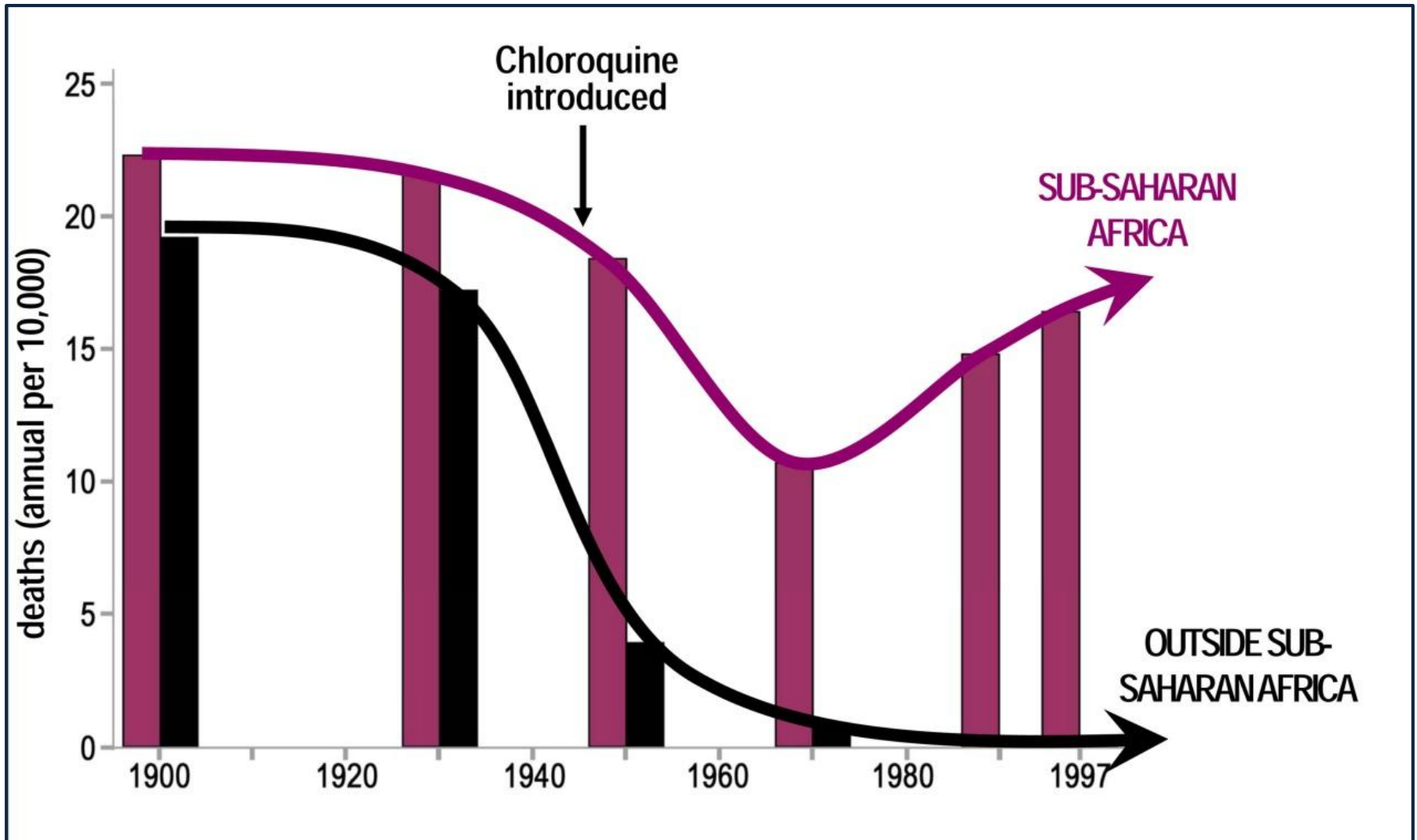
Malaria Deaths and Human Development Index in Africa



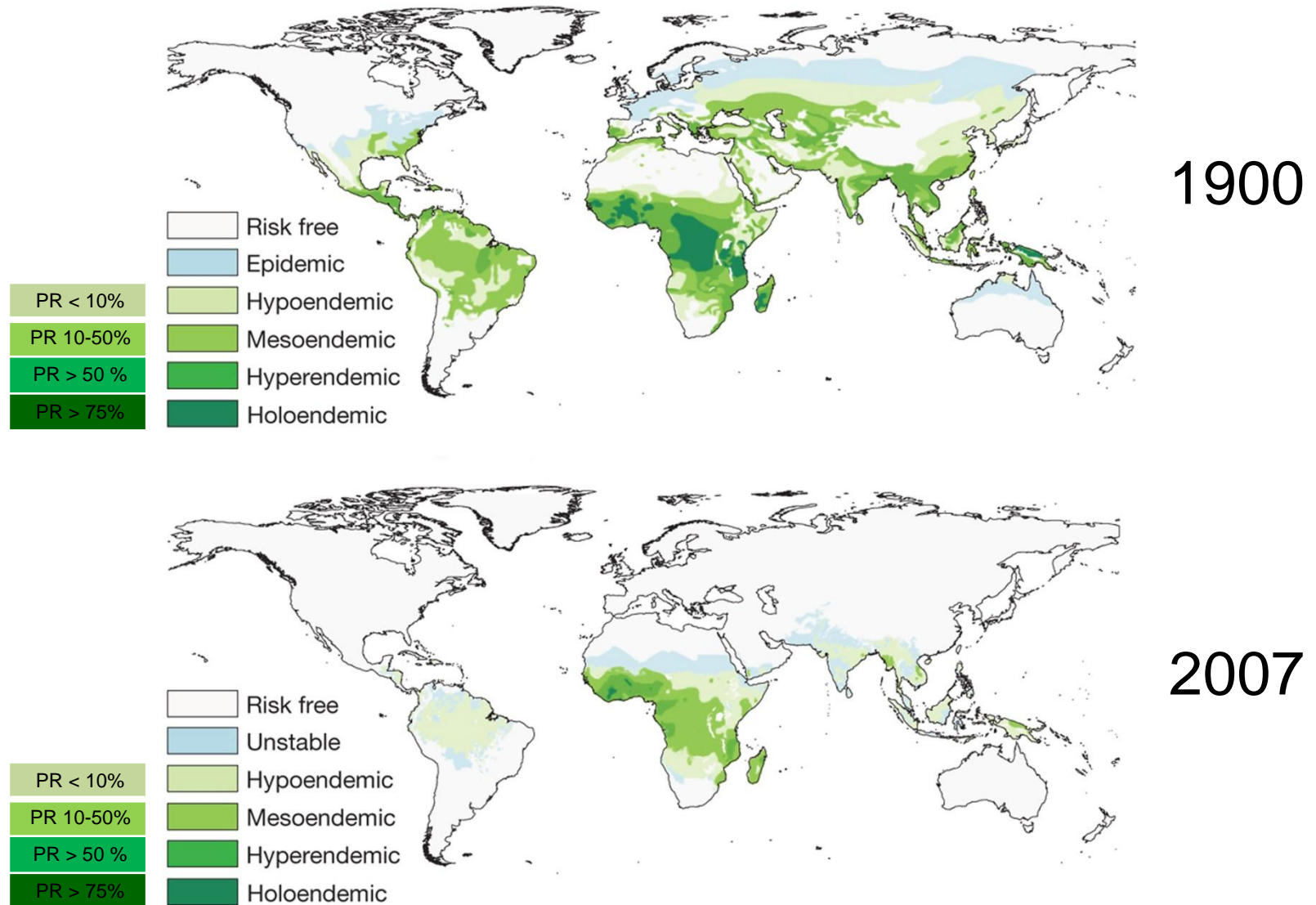
Global Malaria Incidence and Deaths, 1990-2013



Malaria Death Rates in the 20th Century



Changes in Malaria Endemicity between 1900 and 2007



Malaria Transmission by *Anopheles*



Ronald Ross (1857-1932)



Battista Grassi (1854-1925)



Low, Sambon, & Terzi in the Roman Campagna, 1900

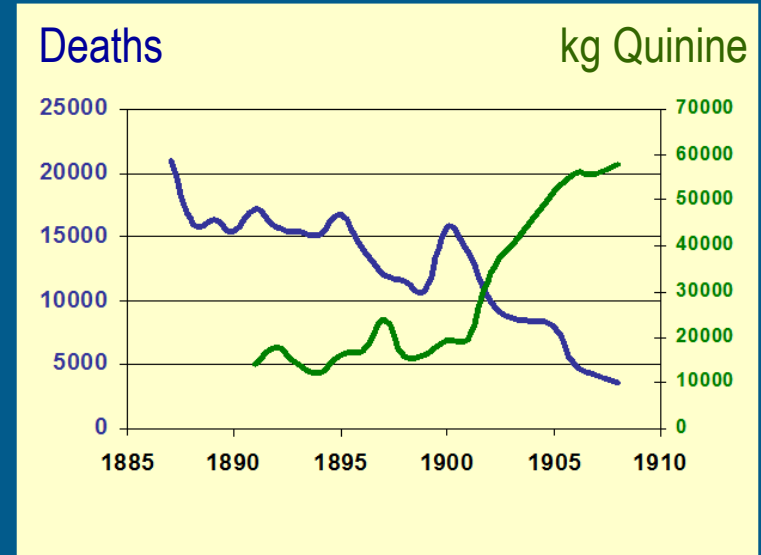


Anopheles gambiae

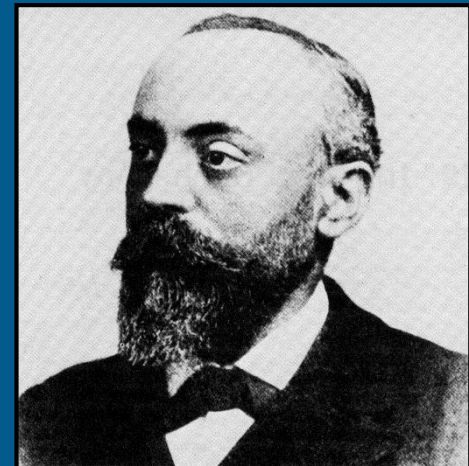
Attacking Malaria Deaths in Italy



“Alms for the poor, struck down in the Campagna. 1694.”
(Photograph by M. Grizzard (2011) *Clin.Infect.Dis.* May 15, 2012)



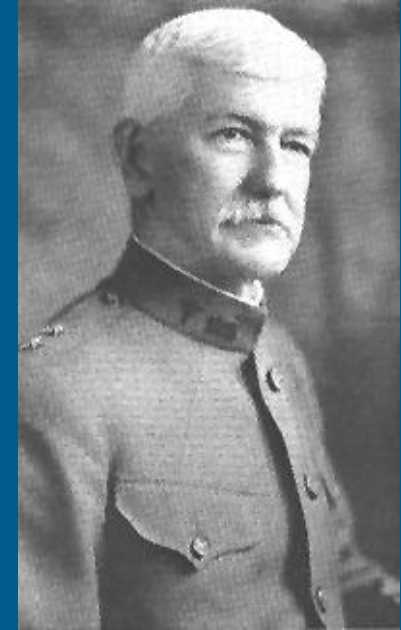
“Unum facere et alterum non omittere”
Angelo Celli (1906)



Success in the Panama Canal



Ancon in the Culebra Cut, 1914

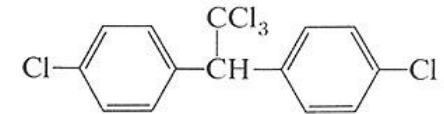


William C. Gorgas (1854-1920)

- Mosquito control and quinine distribution program (40,000 doses/day)
- Reduction of malaria incidence from 800/1000 (1906) to 16/1000 (1916)
- Control of yellow fever

Impact of the 1955-1969 Malaria Eradication Campaign

*“For the first time it is economically feasible for nations
... to banish malaria completely from their borders.”
(P.F. Russell, Man’s Mastery of Malaria, 1955)*

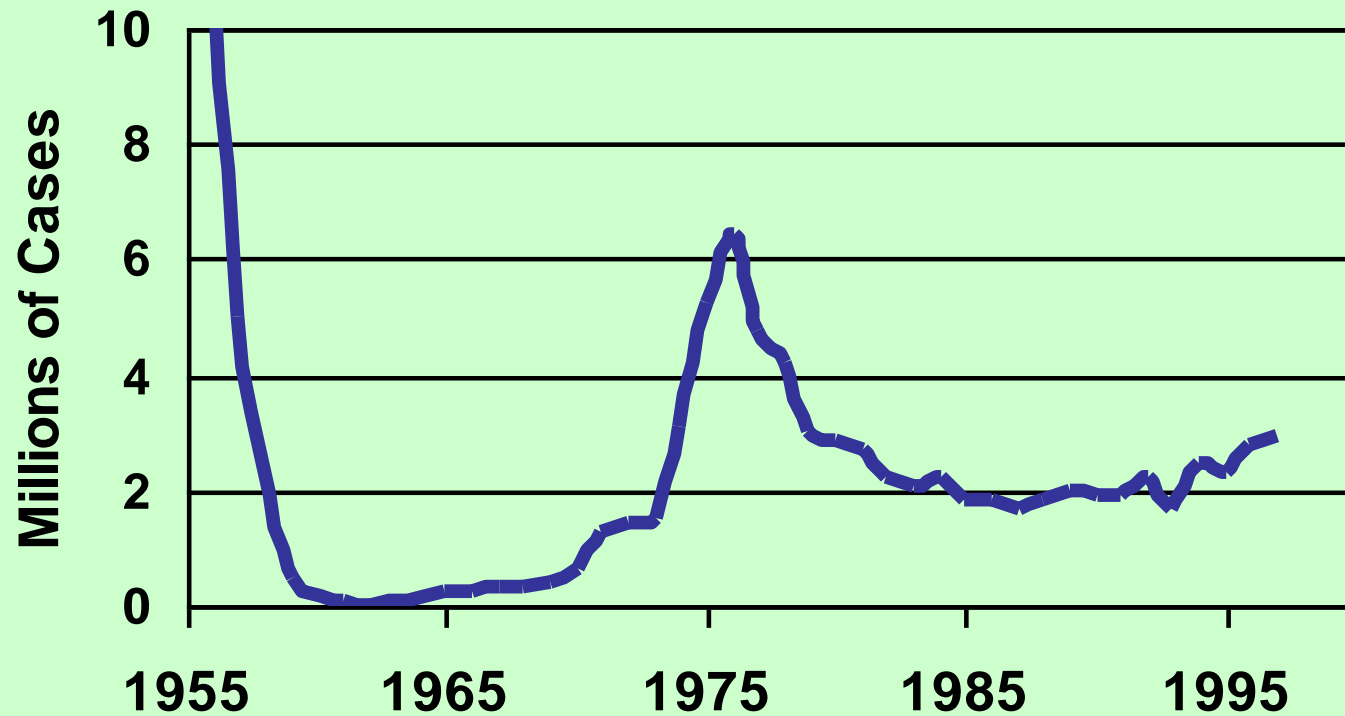


1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
DDT



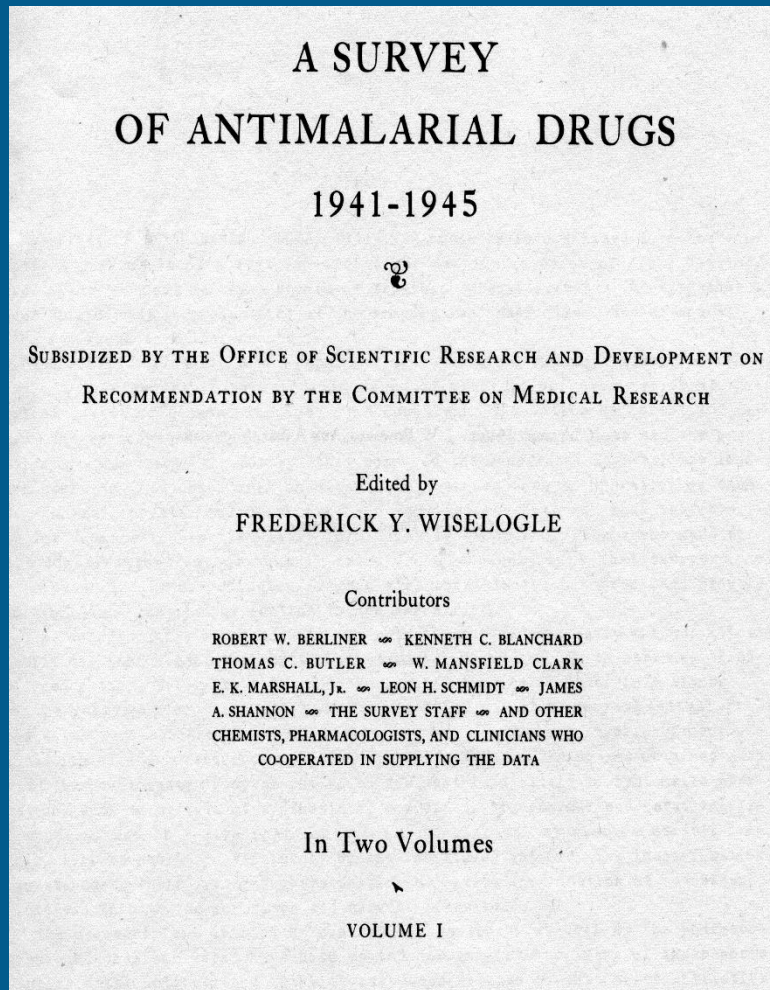
Breakdown of the GMEP and Resurgent Malaria

Malaria Incidence in India

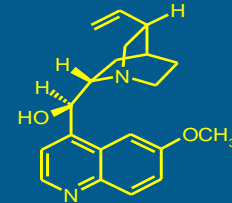


The Route to Chloroquine

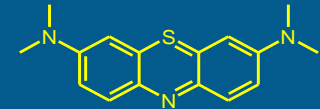
- Quinine and pre-chloroquine synthetic drugs



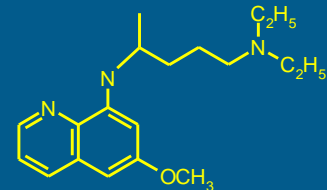
Quinine



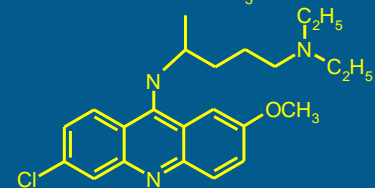
Methylene blue, 1891
(Paul Ehrlich)



Pamaquine, 1926

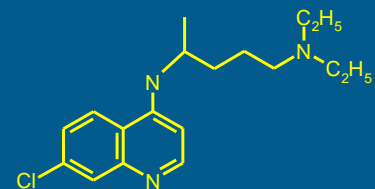


Mepacrine, 1931
(atebrin; quinacrine)

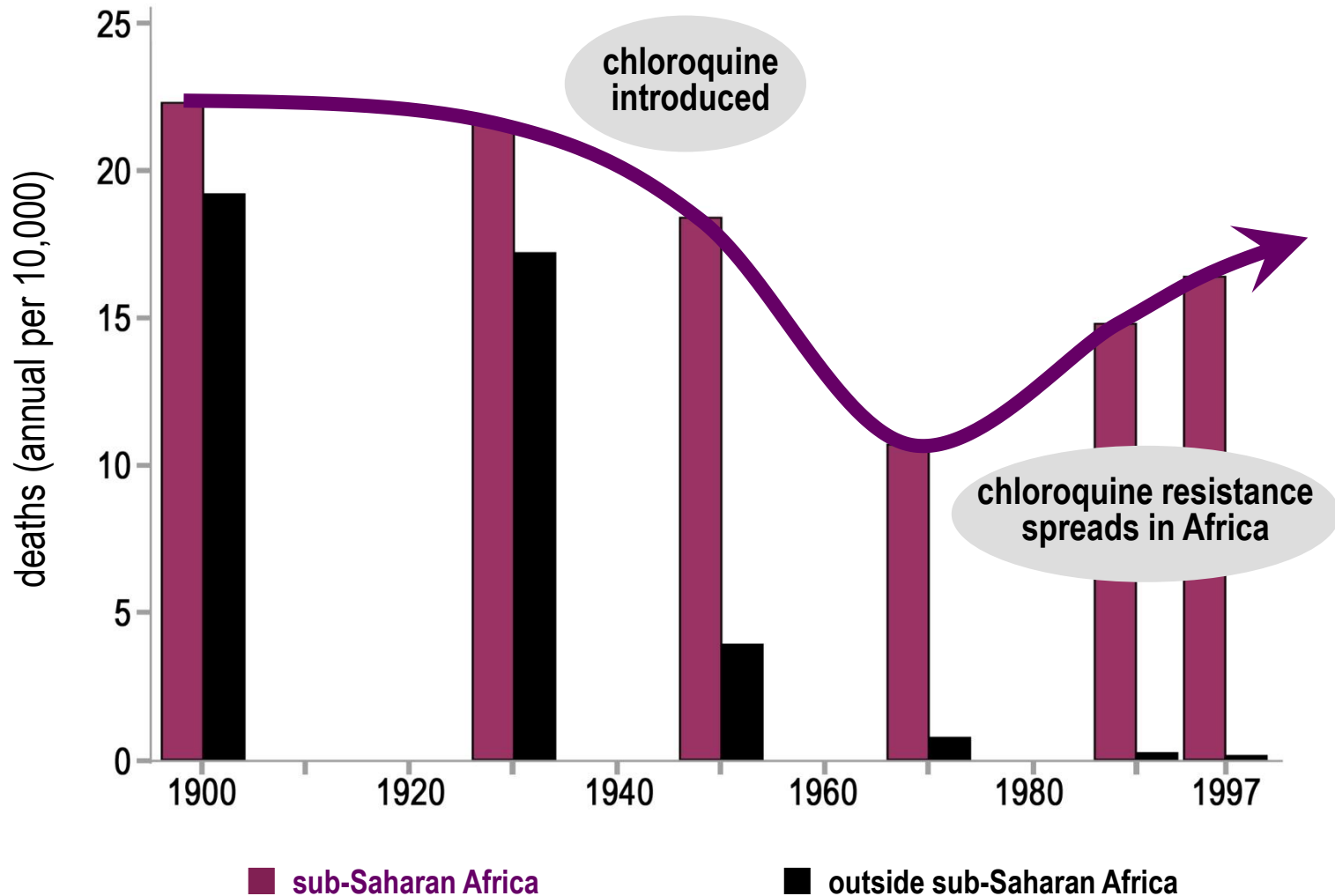


- Chloroquine named antimalarial-of-choice (1945)

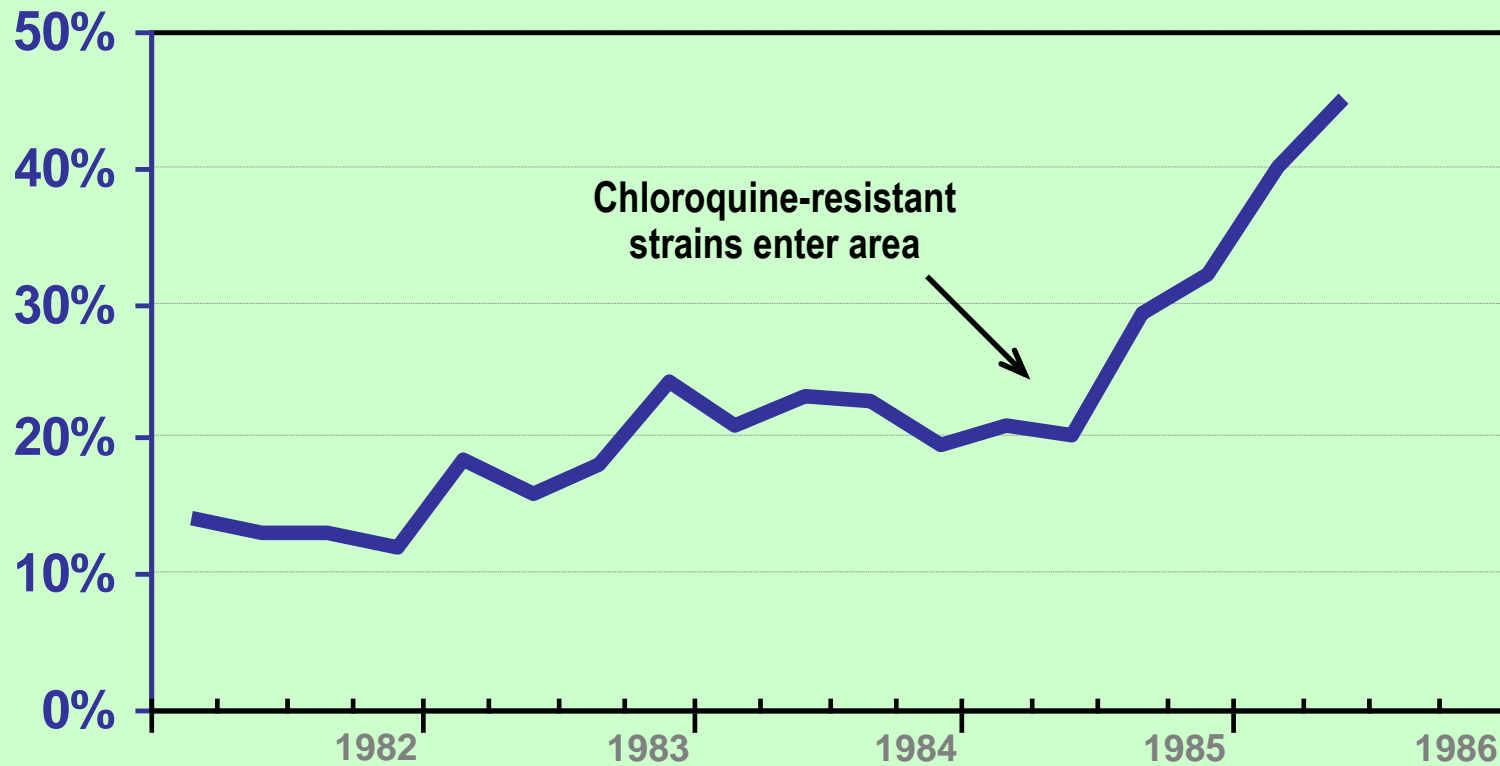
Chloroquine, 1936
(Resochin; SN-7618)



Malaria Death Rates in the 20th Century



Percentage Pediatric Deaths from Malaria, Mama Yemo Hospital



Greenberg *et al.* (1989) *Bull. WHO* 67:189-196

Malaria Programs and Strategies 1955-2025

1955	8 th World Health Assembly adopts Global Malaria Eradication Program, “vertical” strategy with heavy reliance on DDT spraying for aggressive mosquito control. Program ended in 1969 (WHA resolution 22.39).
1978	31 st World Health Assembly adopts a redefined control strategy based on measures adapted to local epidemiological conditions and resources available (“stratification”).
1992	Revised Global Malaria Control Strategy endorsed by Health Ministers in Amsterdam. Emphasizes <i>disease</i> control based on decentralized, tailored use of anti-transmission measures and antimalarial treatments; capacity and infrastructure strengthening; political commitment; community partnership.
1998	WHO, UNICEF, UNDP and World Bank establish the Roll Back Malaria (RBM) partnership to scale-up resources and coverage by key interventions.
2008	Malaria Eradication Research Agenda (malERA) convened following Gates Foundation Malaria Forum. RBM releases Global Malaria Action Plan.
2014	WHO Global Malaria Program (GMP) is developing a Global Technical Strategy for 2016-2025, to be the foundation for RBM Global Malaria Action Plan 2.

Integrated Approaches of Today's Malaria Control Programs



WORLD MALARIA REPORT 2014



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The MalERA Initiative (2011 PLoS Collection)

PLoS MEDICINE

malERA a research agenda
for malaria eradication

www.ploscollections.org/malERA2011



Produced with support from the Malaria Eradication Research Agenda (malERA) initiative, which was funded by a grant from the Bill & Melinda Gates Foundation.

The PLoS Medicine editors have sole editorial responsibility for the content of this collection.
Image: Grassi, B. Studi di uno zoologo sulla malaria (1901), courtesy of the Biodiversity Heritage Library.

PUBLIC LIBRARY OF SCIENCE www.plos.org Volume 8 | Issue 1 | January 2011

PLoS MEDICINE

malERA – a research agenda for malaria eradication
www.plosmedicine.org/malera2011

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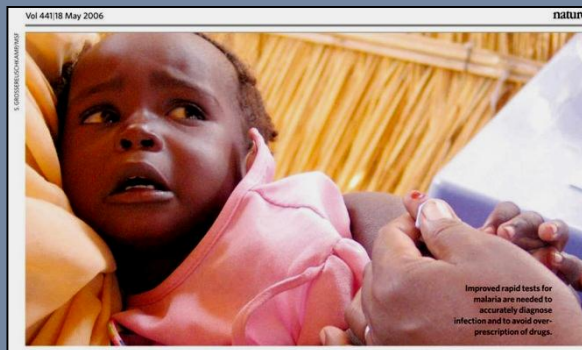
Effective Malaria Programs Requires Multiple Tools (Interface of Molecular Parasitology and Global Health)



Mosquito Transmission Control



Effective Treatments Everywhere

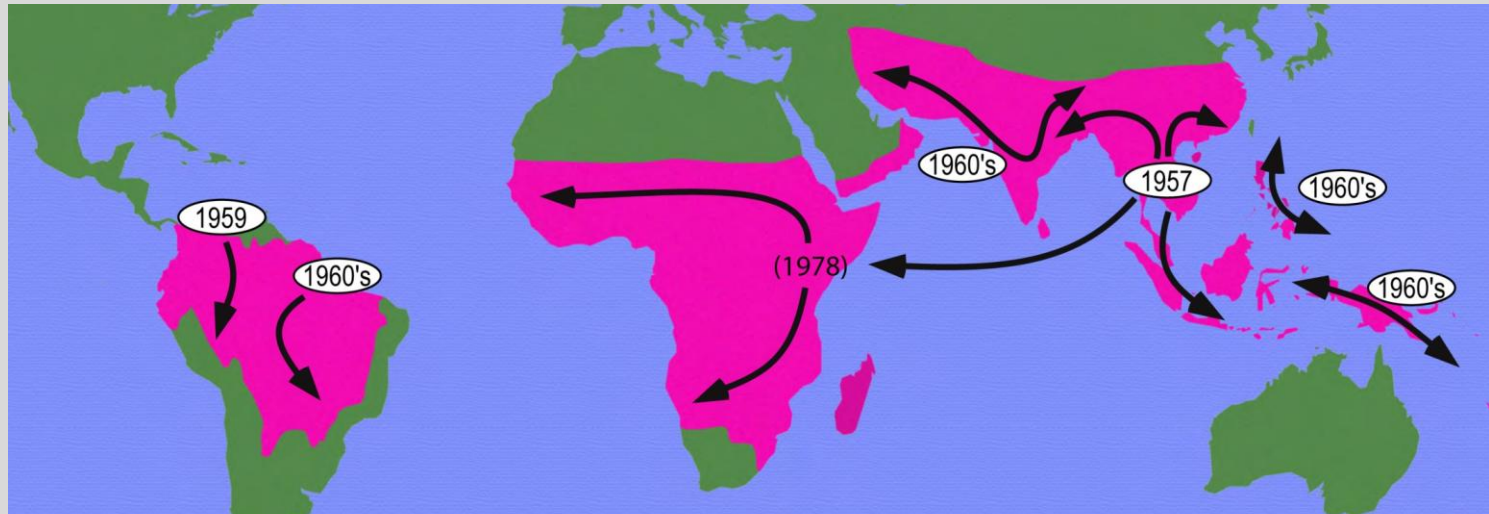


Rapid Diagnostic Tests



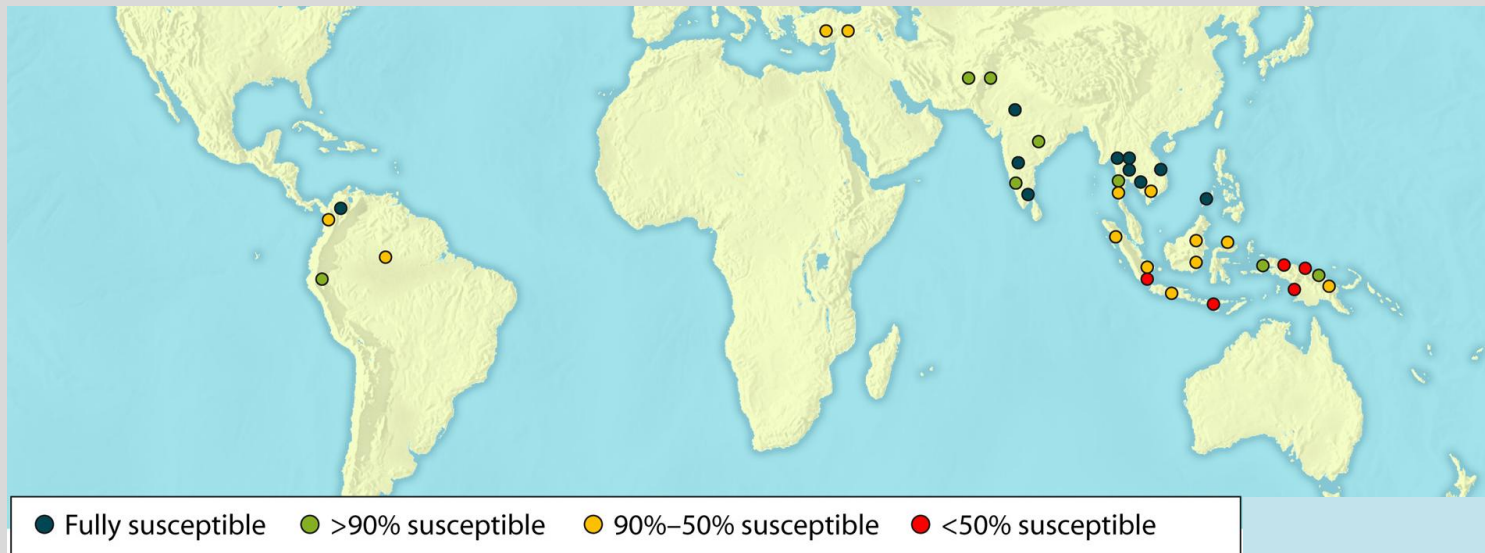
Malaria Vaccines

P. falciparum Chloroquine Resistance



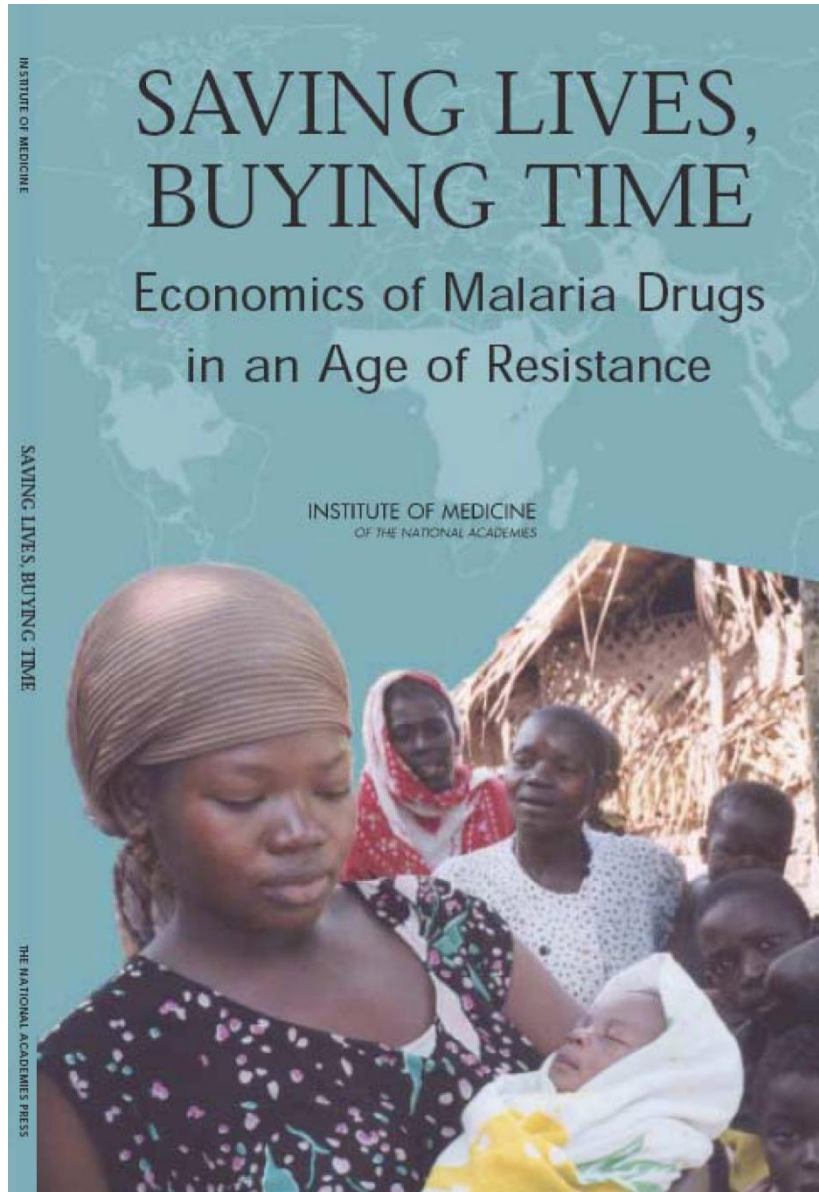
Wellems *et al.* (2009) *J.Clin.Invest.* **119**: 2496-2505

P. vivax Chloroquine Resistance



Baird (2009) *Clin.Microbiol.Rev.* **22**: 508-534

Antimalarial Drugs: Quality, Affordability, Access

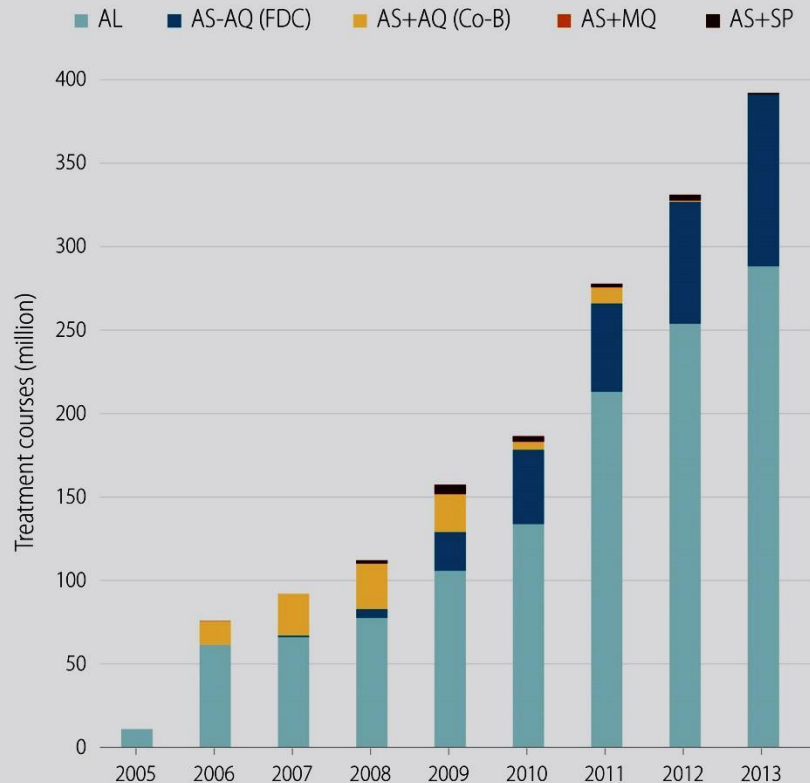


Institute of Medicine Report 2004
recommendation:

*a sustained global subsidy of
artemisinin coformulated with
other antimalarial drugs (ACTs)*

Increasing Use of ACTs for Malaria Treatment

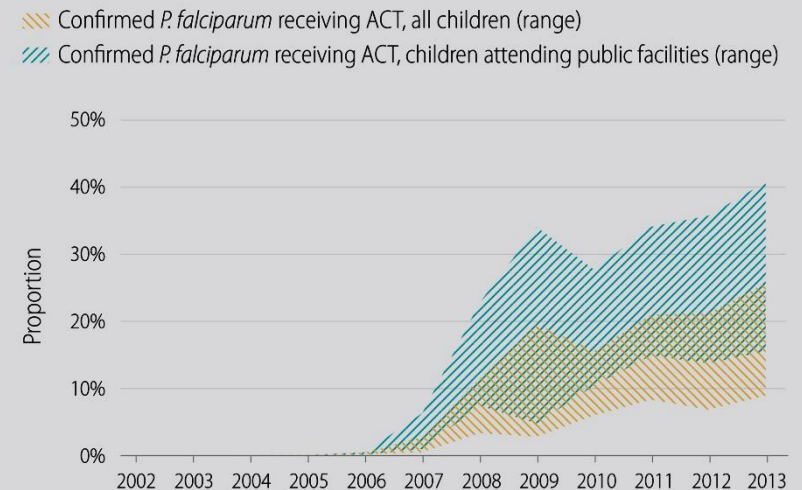
ACT deliveries from manufacturers to the public and private sectors, by drug and presentation, 2005–2013



ACT, artemisinin-based combination therapy; AL, artemether-lumefantrine; AMFm, Affordable Medicine Facility–malaria; AQ, amodiaquine; AS, artesunate; Co-B, co-blister; FDC, fixed-dose combination; MQ, mefloquine; SP, sulfadoxine-pyrimethamine

Source: ACT deliveries (2005–2013*), data provided by eight companies eligible for procurement by WHO/UNICEF.

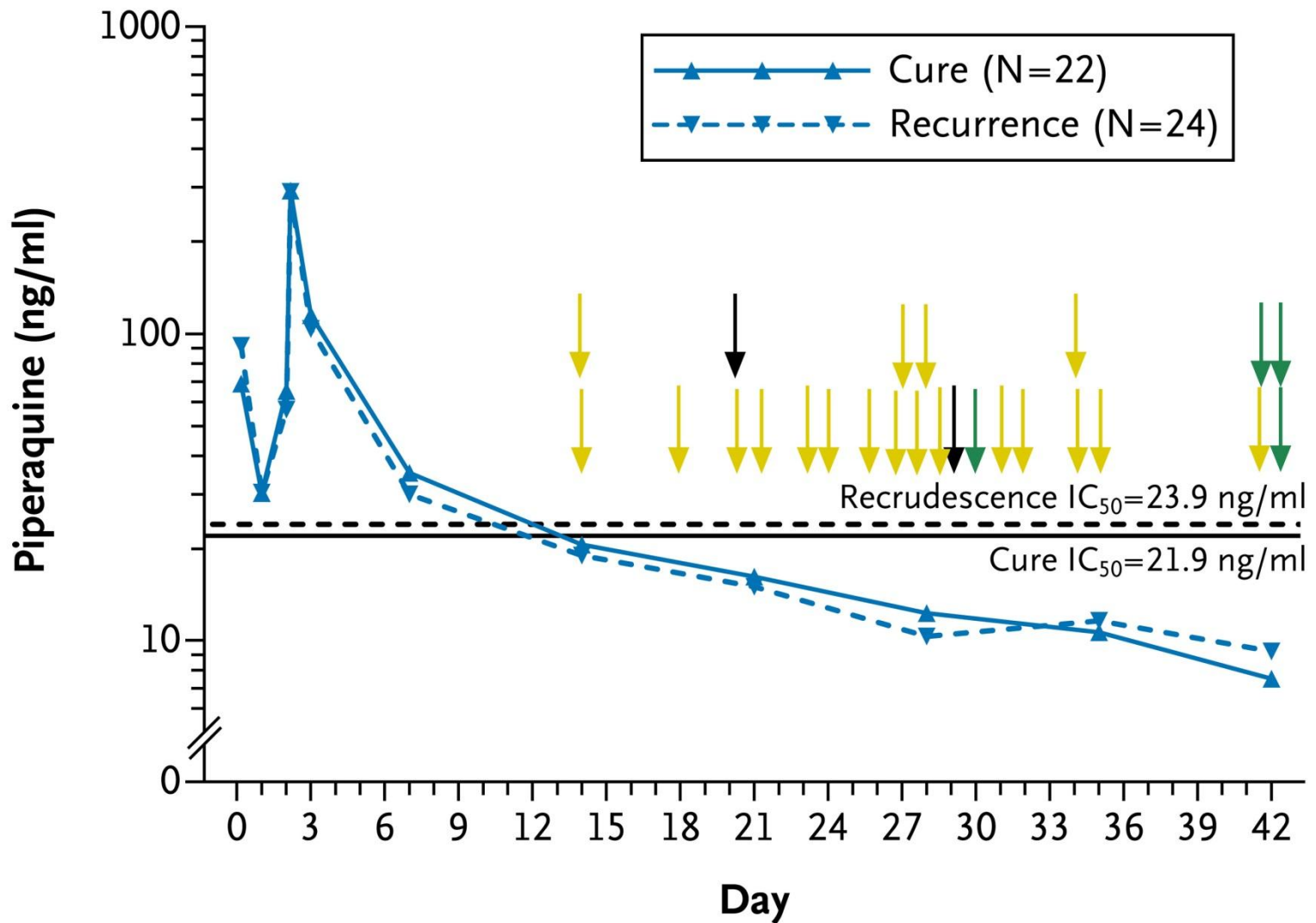
Estimated proportion of children aged under 5 years with confirmed *P. falciparum* malaria who received ACTs, sub-Saharan Africa, 2002–2013



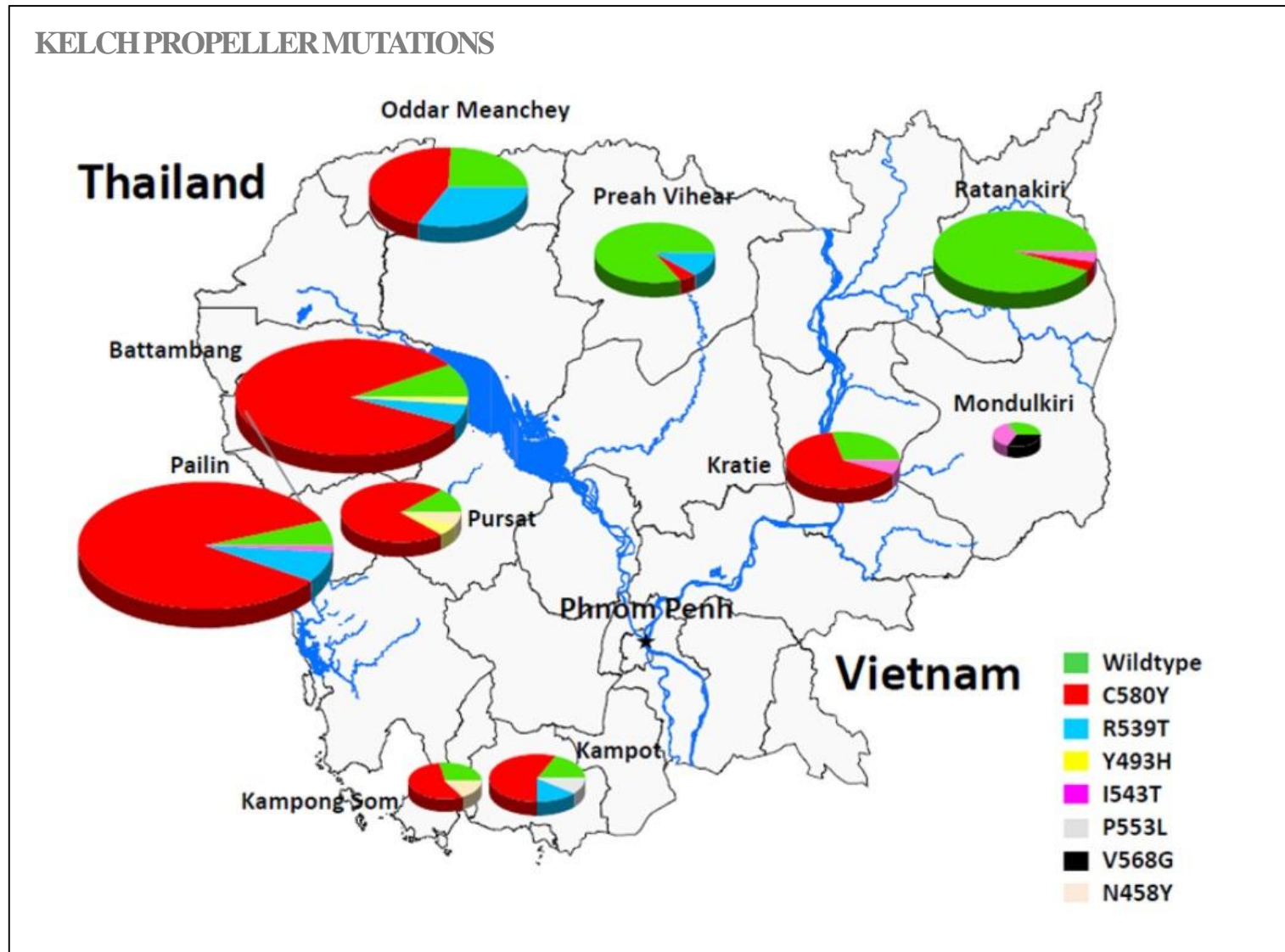
ACT, artemisinin-based combination therapy

Source: Household survey data modelled by Tulane University and University of California, San Francisco

Dihydroartemisinin-Piperaquine Failure in Cambodia



Marker of Delayed Clearance after Artemisinin Treatment in SE Asia



FINANCIAL TIMES

FRIDAY SEPTEMBER 16 2005

Business Life

PUBLIC-PRIVATE PARTNERSHIPS

An antidote to neglected diseases

Alliances of drugmakers, governments and charities are reviving research into overlooked health problems, writes Andrew Jack

‘Public-private partnerships work. They are cheap, effective and the best outcome for public health’

HOW PUBLIC-PRIVATE PHARMACEUTICALS PARTNERSHIPS WORK

Public-private partnerships are a promising new way to develop drugs for the “neglected diseases” of the developing world, where the commercial market is usually too small to attract pharmaceutical companies.

The approach of those large companies that are still working in this sector is normally conducted on a “no profit, no loss” basis, and few companies that have withdrawn from the area would be willing to return, even with considerable extra governmental incentives.

Against this background, public-private partnerships have advantages, as well as their own hurdles to overcome.

■ **Expertise.** PPPs – using employees and advisers with both industry and non-profit backgrounds – can help provide funding, focus and assistance in clinical trials in developing countries, and subsequent registration and distribution.

■ **Collaboration.** Other pharmaceutical companies may be willing to share expertise or compounds through PPPs, which they would not offer to direct competitors.

■ **Agility.** Smaller companies may have sufficiently low overheads, or a desire to market one or two late-stage products, to produce neglected disease drugs commercially.

■ **Challenges.** PPPs’ main weakness is that they are under-funded, and still largely supported by charitable organisations, while governments have focused on alternative inappropriate incentives and provided little money to date.

■ **Future incentives.** The work of PPPs could be further boosted through co-operating to cut costs, a reduction in patent fees, start-up funding, a prize for companies carrying out the neglected disease research and international donations to help countries purchase and distribute such drugs once developed.

MMV Supported Projects, 4Q 2014

Research Lead optimisation		Translational		Development			Access Post Approval
		Preclinical	Human volunteers	Patient exploratory	Patient confirmatory	Under review *	
Miniportfolio Novartis	1 Project Novartis	P218 DHFR BIOTEC (Monash/LSHTM)	DSM265 NIH/Takeda	OZ439/PQP Sanofi	Tafenoquine GSK	Rectal Artesunate CIPLA/Strides/TDR	Artemether-Lumefantrine Dispersible Novartis 1
Miniportfolio GSK	3 Projects GSK	SJ733 St Jude (Rutgers/NIH)	MMV048 UCT/TIA	OZ439/FQ Sanofi	DHA- Piperaquine Paediatric Sigma-Tau	Pyronaridine-Artesunate Paediatric Shin Poong/Iowa	Artesunate for injection Guilin 2
Miniportfolio AstraZeneca	Orthologue Leads Sanofi	MMV121 (Dundee)		KAE609 Novartis		* First review or approval by WHO Prequalification, or by regulatory bodies who are ICH members or observers	DHA-Piperaquine Sigma-Tau 3
Heterocycles Celgene	Oxaboroles Anacor	PA92 (Drexel/UW/GNF)		KAF156 Novartis			Pyronaridine-Artesunate Shin Poong 4
Heterocycles Campinas	Tetraoxanes LSTM/Liverpool	MMV253 (AstraZeneca)					Artesunate Amodiaquine Sanofi/DNDi 5
Screening Daiichi-Sankyo	DHODH UTSW/UW/Monash	GSK030 GSK					Artesunate-Mefloquine CIPLA/DNDi
Screening Takeda	Aminopyridines UCT						Sulfadoxine Pyrimethamine+ Amodiaquine Guilin
Screening Eisai	Open Source Drug Discovery Sydney						
Pathogen Box MMV	Amino-alcohols Merck Serono						
Other Projects 15 Projects							

□ Included in MMV portfolio post approval

- 1 Brand name: Coartem® Dispersible
 2 Brand name: Artesun®
 3 Brand name: Eurartesim®
 4 Brand name: Pyramax®
 5 Brand names: Coarsucam™, ASAQ/Winthrop®

William Trager, 1910-2005

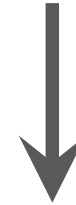


STUDIES ON CONDITIONS AFFECTING THE SURVIVAL IN VITRO
OF A MALARIAL PARASITE (*PLASMODIUM LOPHURAE*)

BY WILLIAM TRAGER, PH.D.

(From the Department of Animal and Plant Pathology of The Rockefeller Institute
for Medical Research, Princeton, New Jersey)

J. Exp. Med. (1941) 74:441-462



HUMAN MALARIA PARASITES IN CONTINUOUS
CULTURE

W Trager and JB Jensen

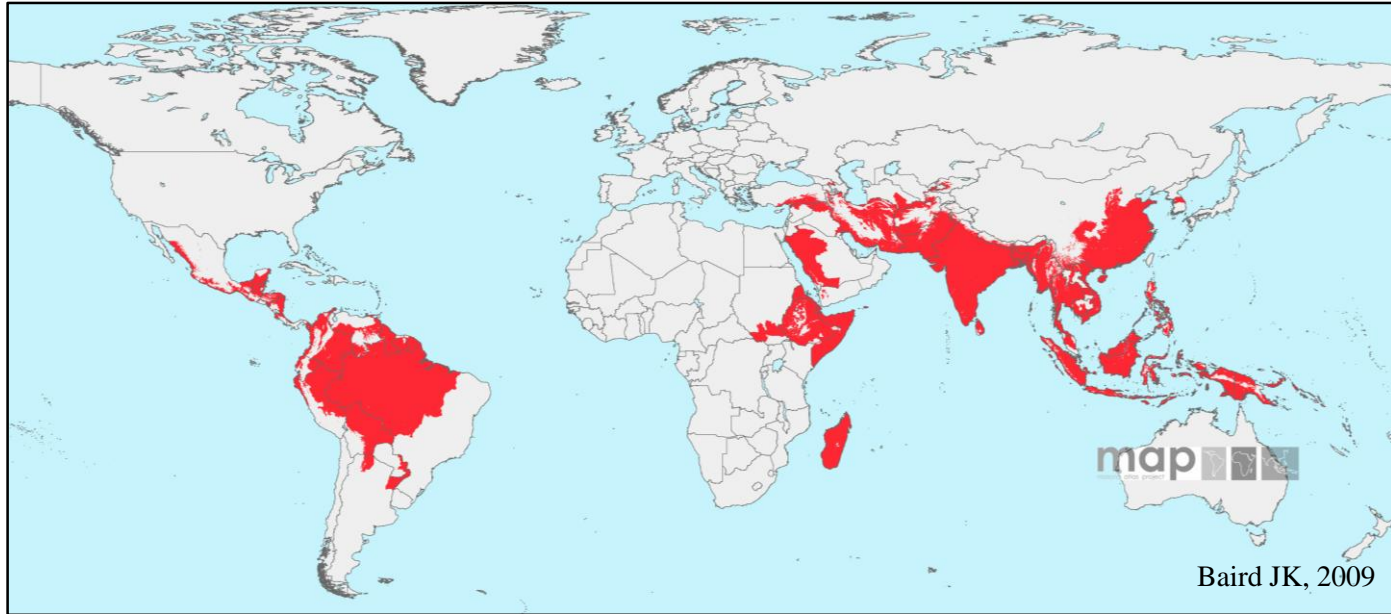
Science (1976) 193: 673-675

“The impact of continuous cultivation of *P. falciparum* was phenomenal. It spawned a renaissance of research on the immunology, cell biology and molecular biology of this parasite.”

Sherman and Simpson (2013) *National Academy of Sciences*

<http://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/trager-william.pdf>

P. vivax Burden: 70 – 390 million Cases Annually



“You can’t study something you can’t grow” (W. Trager)

- *P. vivax* is a pathogen of major global impact
- Drug screening and vaccine discovery depend upon non-human primate and human infections for parasite material
- Until *in vitro* cultivation is solved, molecular and genetic progress on *P. vivax* will be slow and limited



Children under 5 years are the most affected: **Every minute 1 child dies** of malaria



1/3

OF ANTIMALARIALS
IN AFRICA ARE FAKE



In sub-Saharan Africa - where the burden of malaria is the greatest - the prevalence of fake medicines can be even higher



In Ghana and Cameroon:
up to 40% are fake

In Nigeria:
up to 64% are fake



It has been estimated that fake antimalarial medicines contribute to nearly **450,000 preventable deaths every year**⁶



Fake antimalarial medicines kill hundreds of children every day⁷. Every 5 minutes a child dies of malaria because of taking fake medicines.

FAKE ANTIMALARIALS

- result directly in deaths and morbidity⁸
- increase the incidence of adverse effects⁹
- diminish patients' and health practitioners' confidence in genuine antimalarial medicines⁹ and health service providers¹⁰
- increase the risk of the emergence and spread

CASE STUDIES



In 2005, a 23 year old man died in Eastern Myanmar from cerebral malaria after being given fake medicine, bought in good faith by his local hospital. When the village committee discovered the cause of this needless death, they were sufficiently angry to collect all packs of these fake antimalarials they could find in local shops and burnt them in front of the whole village.



In 2009, Nigeria intercepted a consignment of nearly 700,000 doses of fake antimalarials. This quantity of fake medicines, if not intercepted, would have been sufficient to give ineffective or dangerous "medications" to hundreds of thousands of pregnant women and children.



In 2012, in Angola, 1.5 million packets of fake malaria medicines were found in a container from China, hidden inside a shipment of loudspeakers. The fake pills contained no active ingredient. Instead, they were made of calcium phosphates, fatty acids and yellow pigment. The fakes — enough to treat more than half the country's annual malaria cases, had they been genuine — are part of a proliferation of bogus malaria drugs in Africa that threaten to undermine years of progress in tackling the disease. A large international investigation is now underway.

RECOMMENDATIONS

- [illegible]

Always buy WHO prequalified antimalarial medicines from a reputable source where medicines are stored properly.

- Always check the packaging carefully;
- Check the expiry date and if the dosage is correct.
- Check if the patient information leaflet is in the correct language

Closely examine the appearance of your medicines:

- Check if the pills are cracked or chipped.

Make sure you have a malaria diagnostic test before taking an antimalarial.

All antimalarial doses must be taken within three days to be effective.

Recovery should be rapid and complete by day three of treatment if the antimalarial medicine is genuine.

Speak with your doctor or pharmacist if you have unusual side-effects after taking your medicines.

If you have any concerns about the quality of your medicines, and/or if you notice an anomaly on the packaging, instructions, blister pack, or pills, contact your health authority or the medicine manufacturer and retain packaging and any tablets for testing.

Home

What is an RDT?

Purchasing and
Using RDTs

RDT Field Trials

RDT Evaluation
Programme

Publications and
documents

Joint Workplan

Useful links

Contacts

Making Rapid Diagnosis Work.....

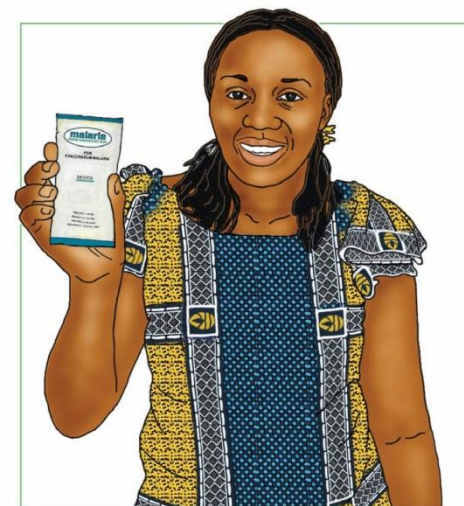
[Malaria](#) Rapid Diagnostic Tests (RDTs) assist in the diagnosis of malaria by detecting evidence of malaria parasites in human blood.

This site aims to:



- Provide information and guidance for malaria RDTs to malaria control programmes and health services, organizations and individuals considering the use of malaria RDTs.
- Provide guidance on evaluation of malaria RDTs.
- Provide information to manufacturers and users on WHO-FIND Malaria RDT Evaluation Programme.

How To Use a Rapid Diagnostic Test (RDT)



A guide for training at a village and clinic level

Tremendously Expanded RDT use:

“The number of RDTs distributed by national malaria control programmes in the public sector has increased from less than 200,000 in 2005 to more than 108 million in 2012. Manufacturers surveyed by WHO for the World Malaria Report 2013 reported a total of 205 million RDT sales in 2012. Data received from countries reveal that most RDTs (78%) were used in the WHO African Region, followed by the South-East Asia Region (16%).”

http://www.who.int/malaria/areas/diagnosis/rapid_diagnostic_tests/en/



Improved rapid tests for malaria are needed to accurately diagnose infection and to avoid over-prescription of drugs.

Neglected tests for neglected patients

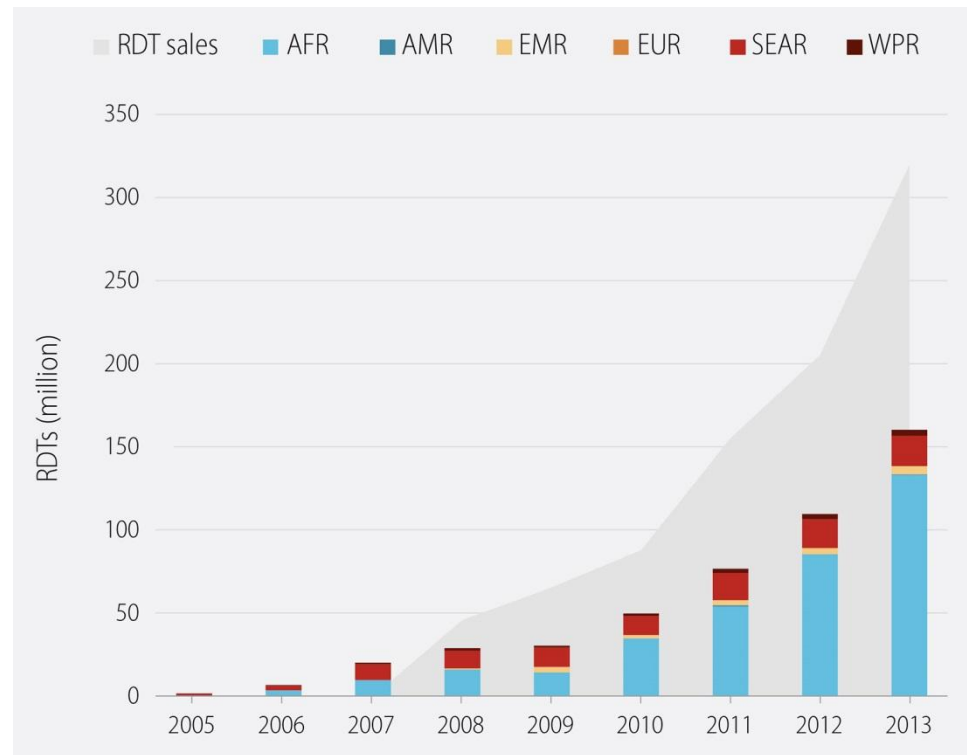
ParaSight^F
Rapid test for *P. falciparum* malaria

No microscope: A color change on a test strip
Screen in minutes for the most dangerous species

Breakthrough technology from Becton Dickinson
Tropical Disease Diagnostics continues the Assault on Malaria

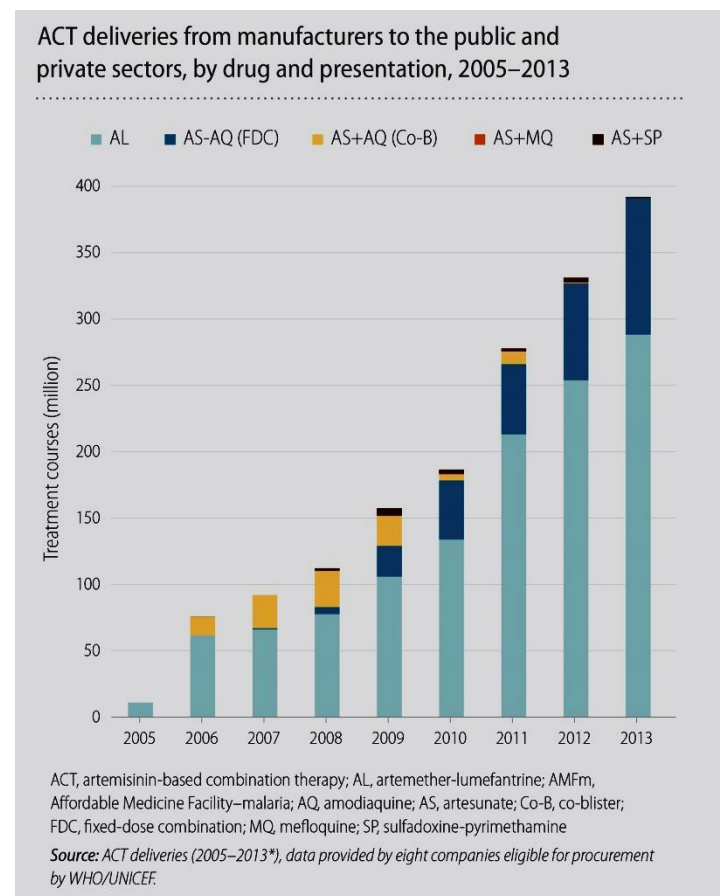
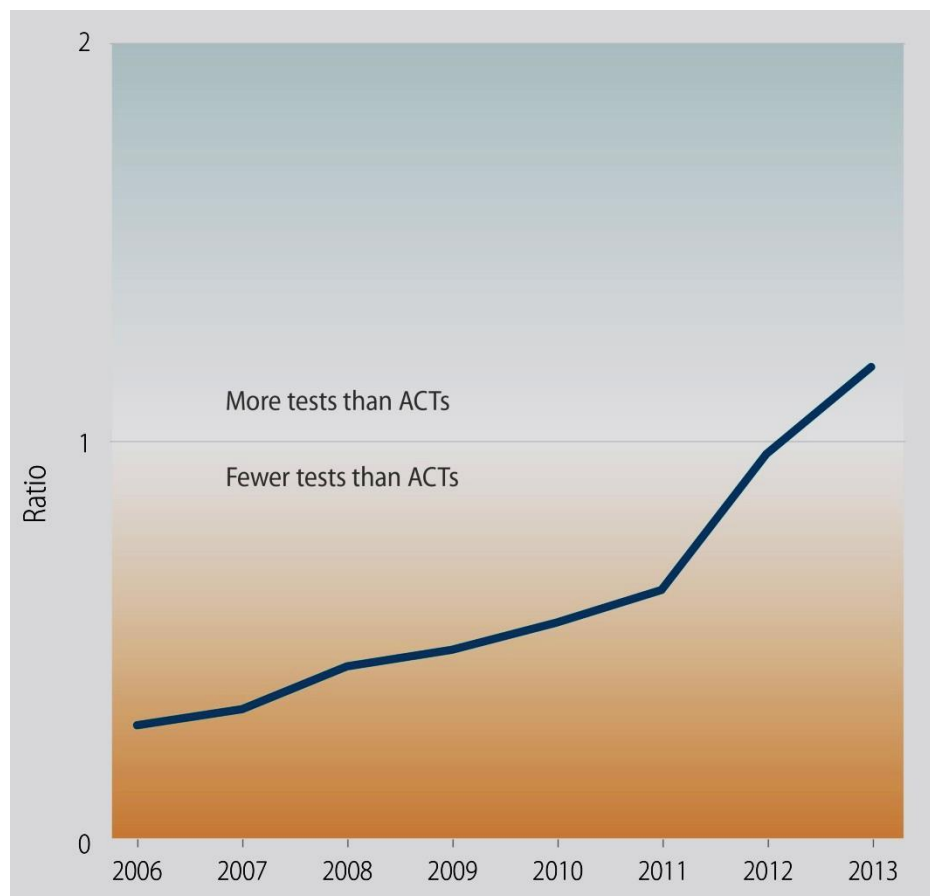
BECTON DICKINSON

Wellems & Howard (1986) Patent US5130416 A;
Shiff, Premji and Minjas (1993) *TRSTMH* 87: 646-648



World Malaria Report (2014)

Malaria Diagnostic Tests/Distributed ACTs, Africa 2006-2013

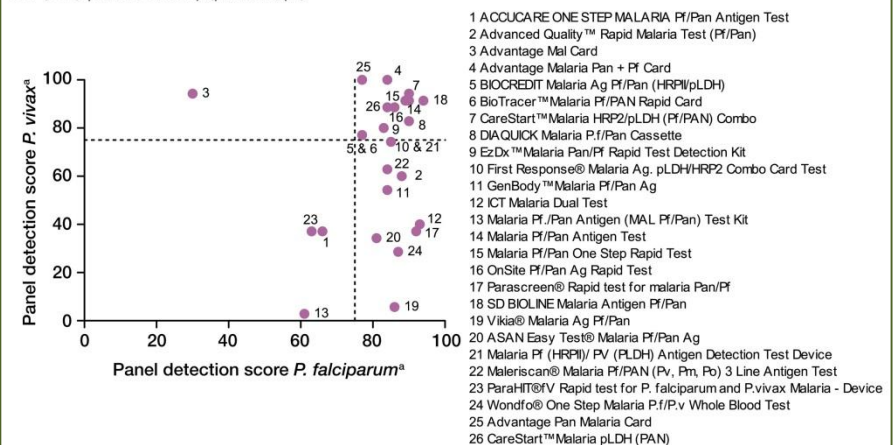


Malaria Rapid Diagnostic Test Performance

Summary results of WHO product testing of malaria RDTs: Round 1-5 (2008-2013)

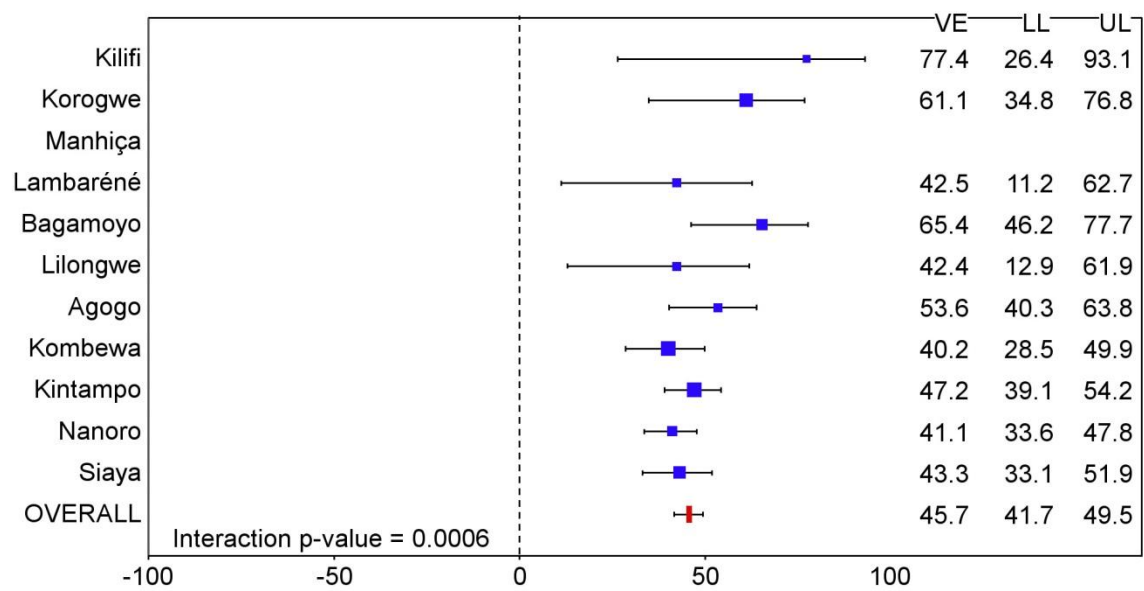
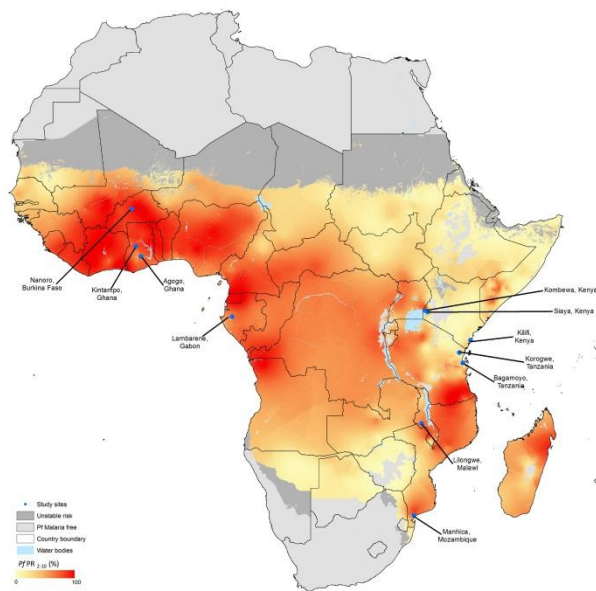


Figure S3: Panel detection score of malaria combination RDTs, meeting WHO procurement criteria for false-positive and invalid rates, in phase 2 of rounds 2-5 against wild-type (clinical) samples containing *P. falciparum* and *P. vivax* at low (200) parasite density (parasites/ μ L)

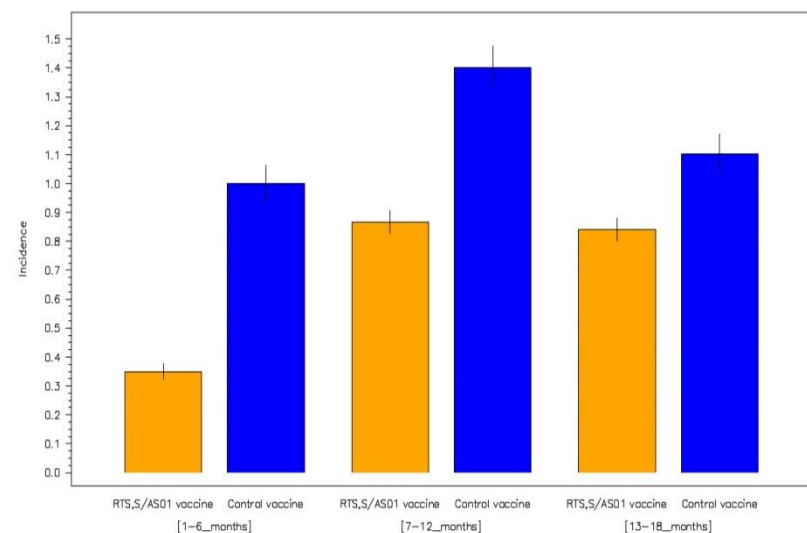


^a Panel detection score – A sample is considered detected only if all RDTs from both lots read by the first technician, at the minimum specified reading time, are positive.

2014: GSK Applies for RTS,S/AS01 Vaccine Regulatory Approval



Children 5-17 months of age at enrollment - clinical malaria



From X-irradiated Sporozoites to the CSP Vaccine (1967-2014)



Ruth Nussenzweig

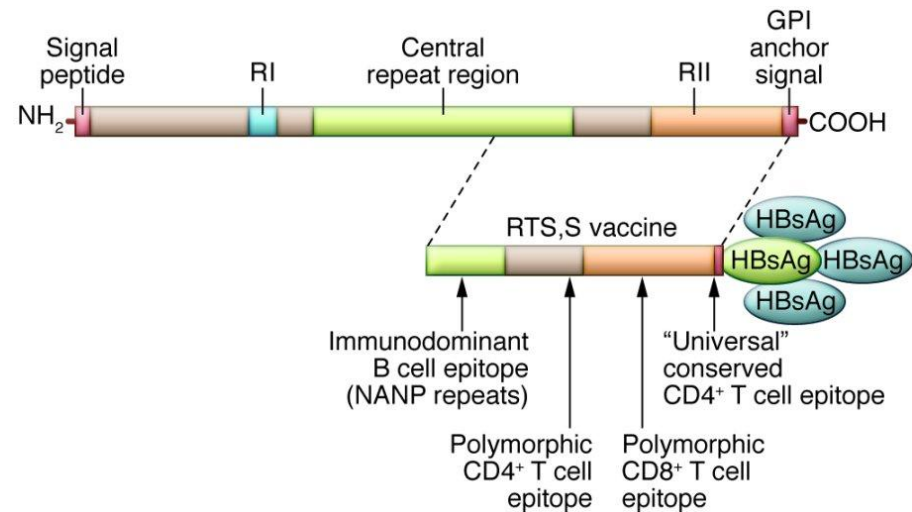
letters to nature

Nature **216**, 160 - 162 (14 October 1967); doi:10.1038/216160a0

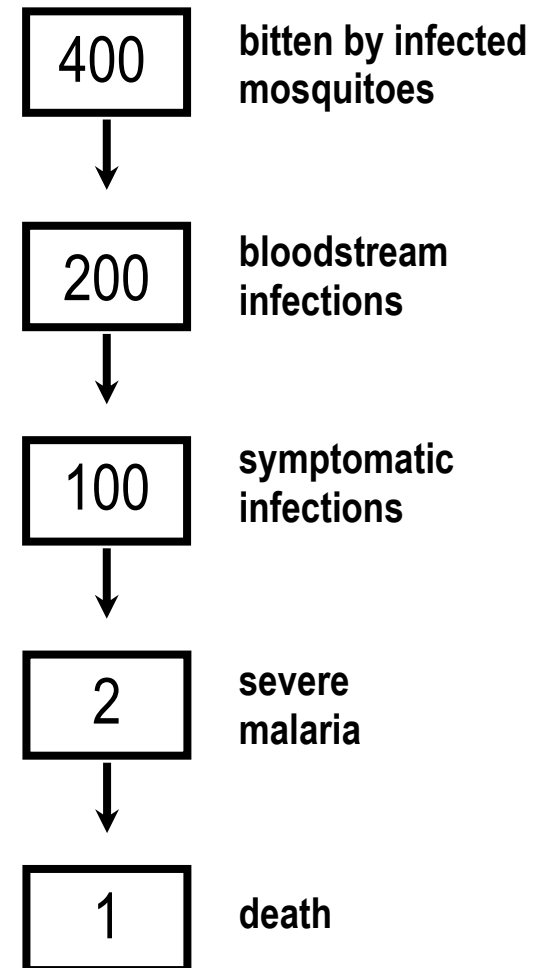
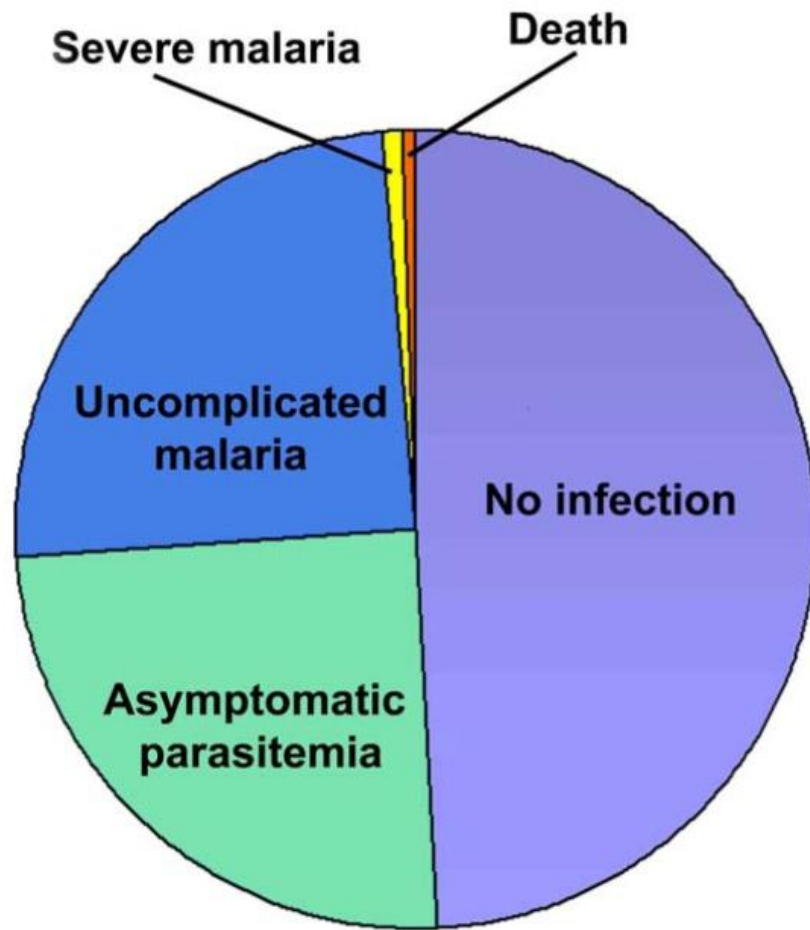
Protective Immunity produced by the Injection of X-irradiated Sporozoites of *Plasmodium berghei*

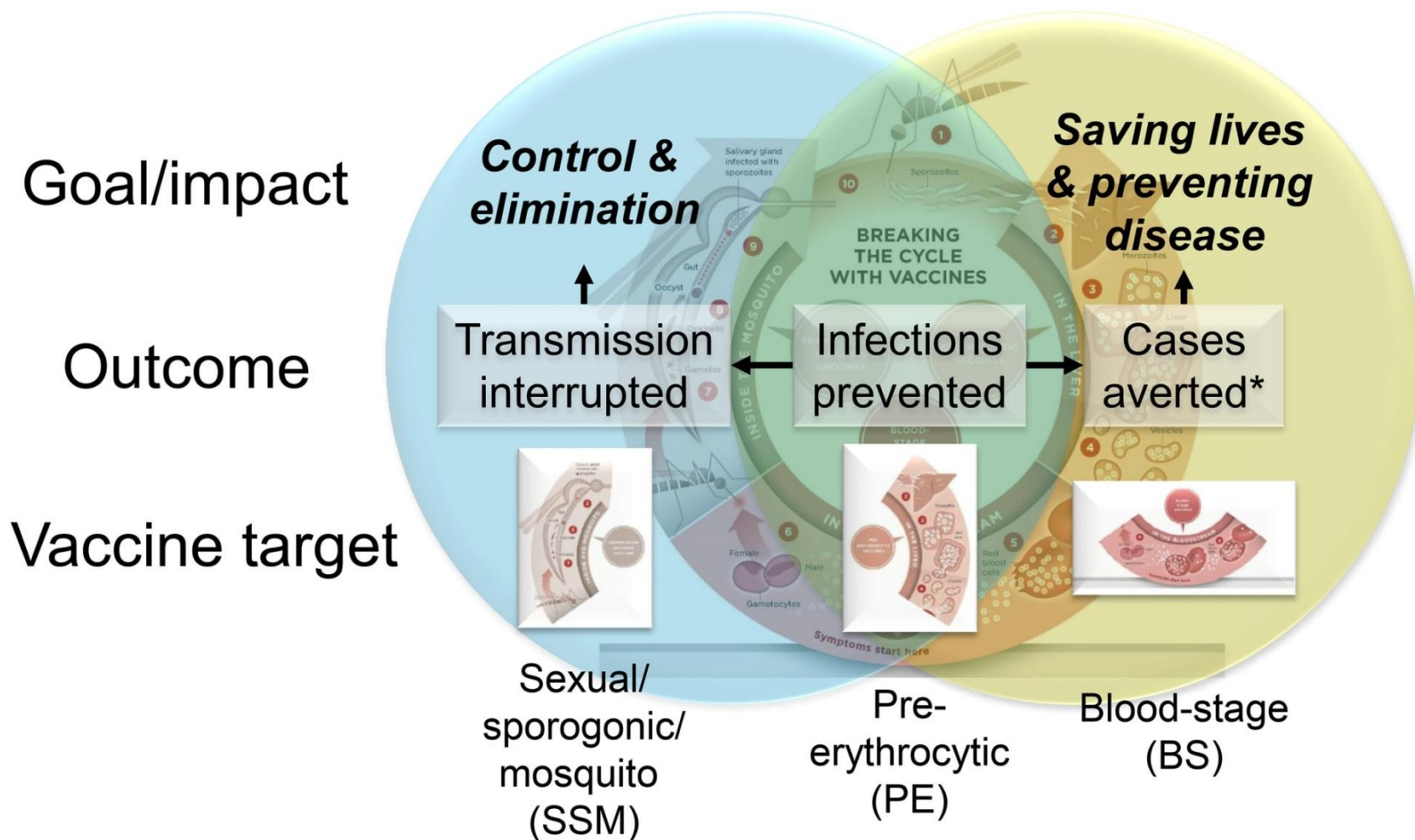
R. S. NUSSENZWEIG, J. VANDERBERG, H. MOST & C. ORTON

Department of Preventive Medicine and Department of Radiology, New York University School of Medicine.

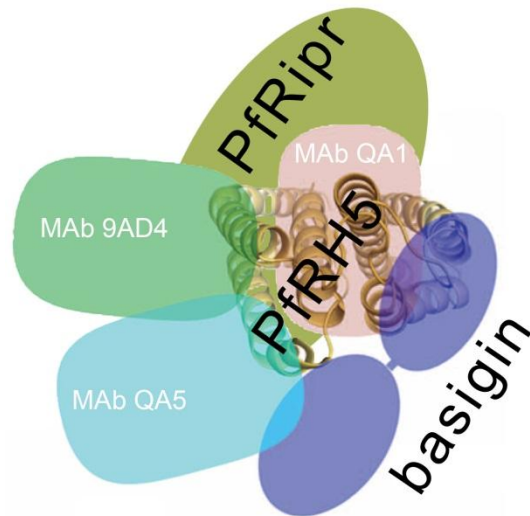


Risk of Infection, Malaria and Death from *P. falciparum* in African Children

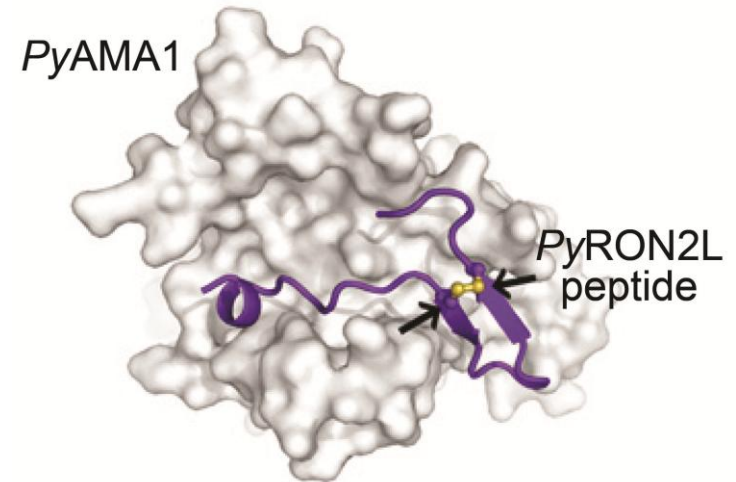
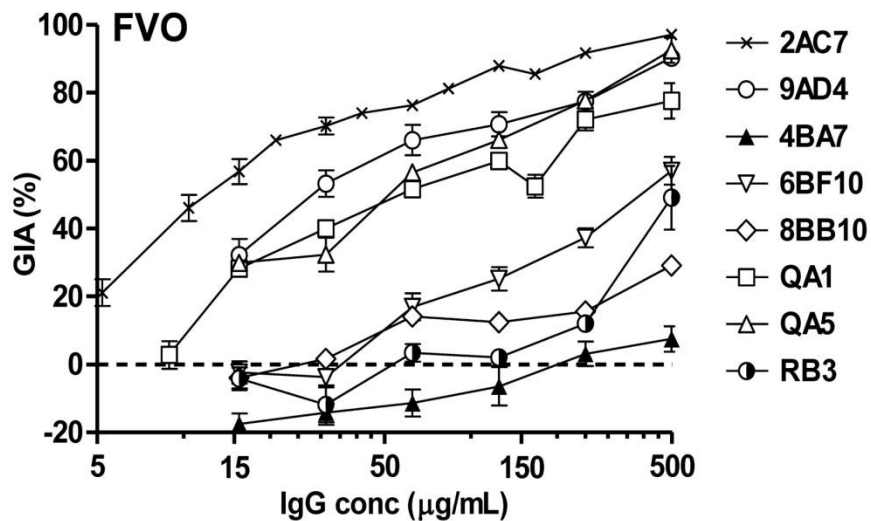




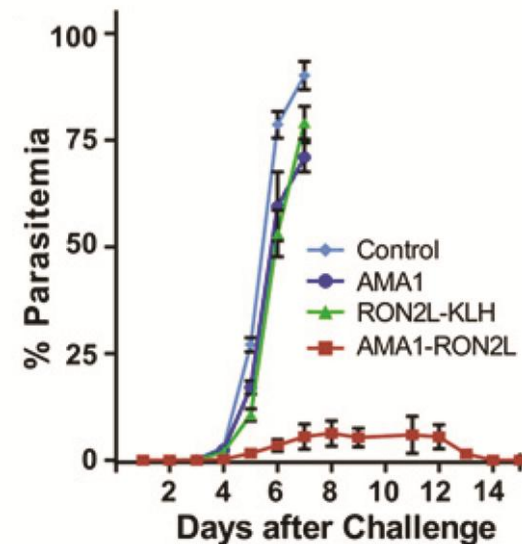
Attacking the Complexes Critical to Erythrocyte Invasion



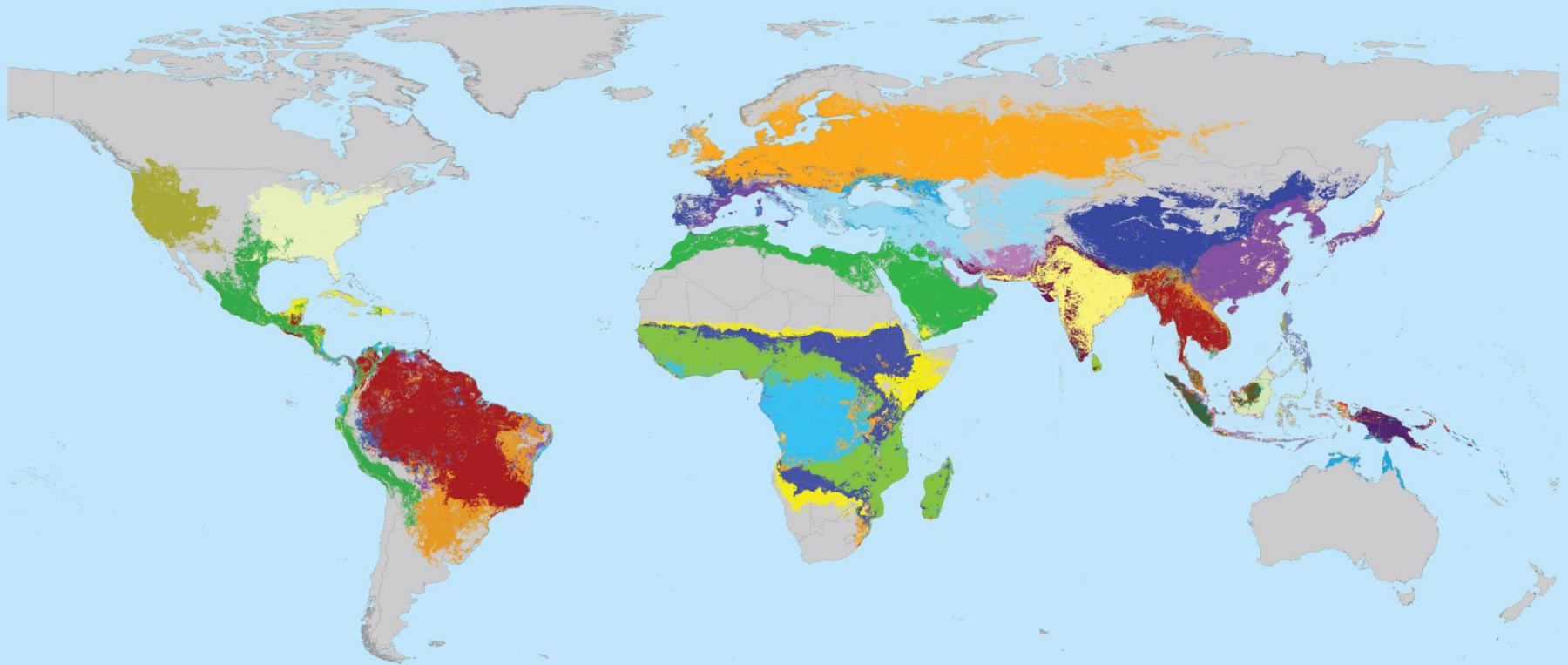
Basigin-PfRH5-PfRipr



PfAMA1-RON2



A global map of dominant malaria vector species



The Americas

- An. darlingi*
- An. aquasalis*
- An. albitarsis* s.l.
- An. marajoara*
- An. nuneztovari* s.l.
- An. pseudopunctipennis*
- An. albimanus*
- An. quadrimaculatus* s.l.
- An. freeborni*

Euro. & M.East

- An. superpictus*
- An. sergentii*
- An. sacharovi*
- An. messeae*
- An. labranchiae*
- An. atroparvus*

Africa

- An. arabiensis*;
- An. funestus*;
- An. gambiae*
- An. arabiensis*;
- An. funestus*
- An. funestus*;
- An. gambiae*
- An. gambiae*
- An. funestus*
- An. arabiensis*

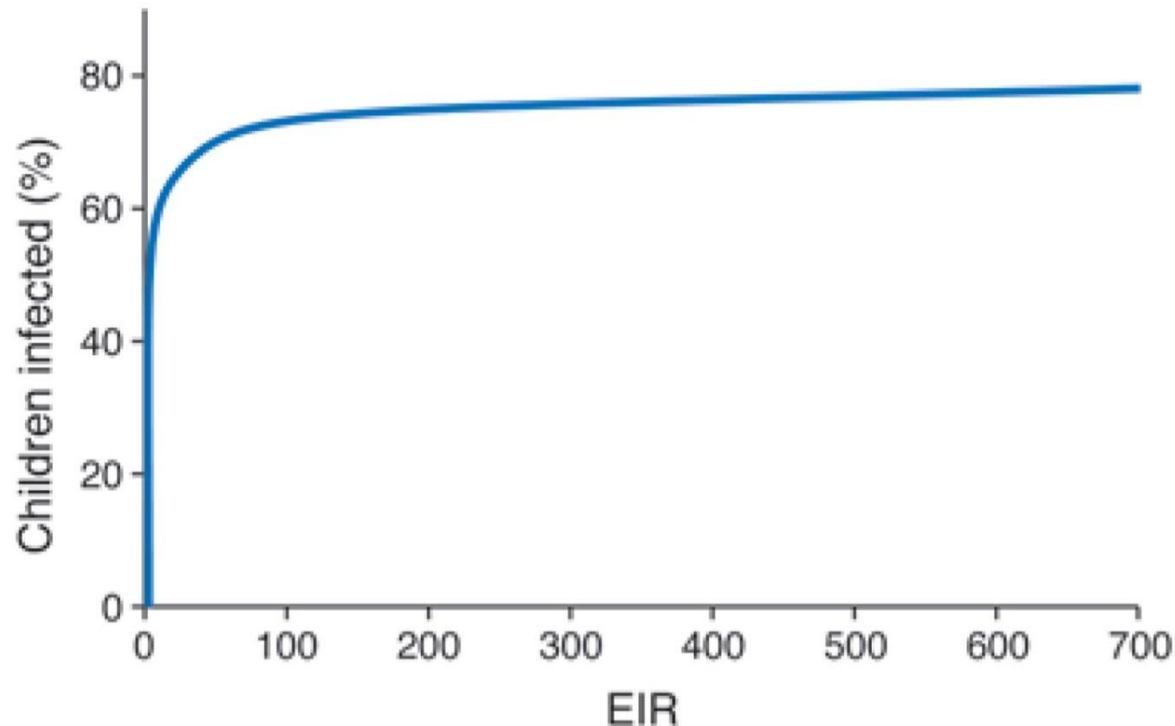
India/Western Asia

- An. culicifacies* s.l.;
- An. stephensi*;
- An. fluviatilis* s.l.
- An. fluviatilis* s.l.
- An. stephensi*
- An. culicifacies* s.l.

South-East Asia & Pacific

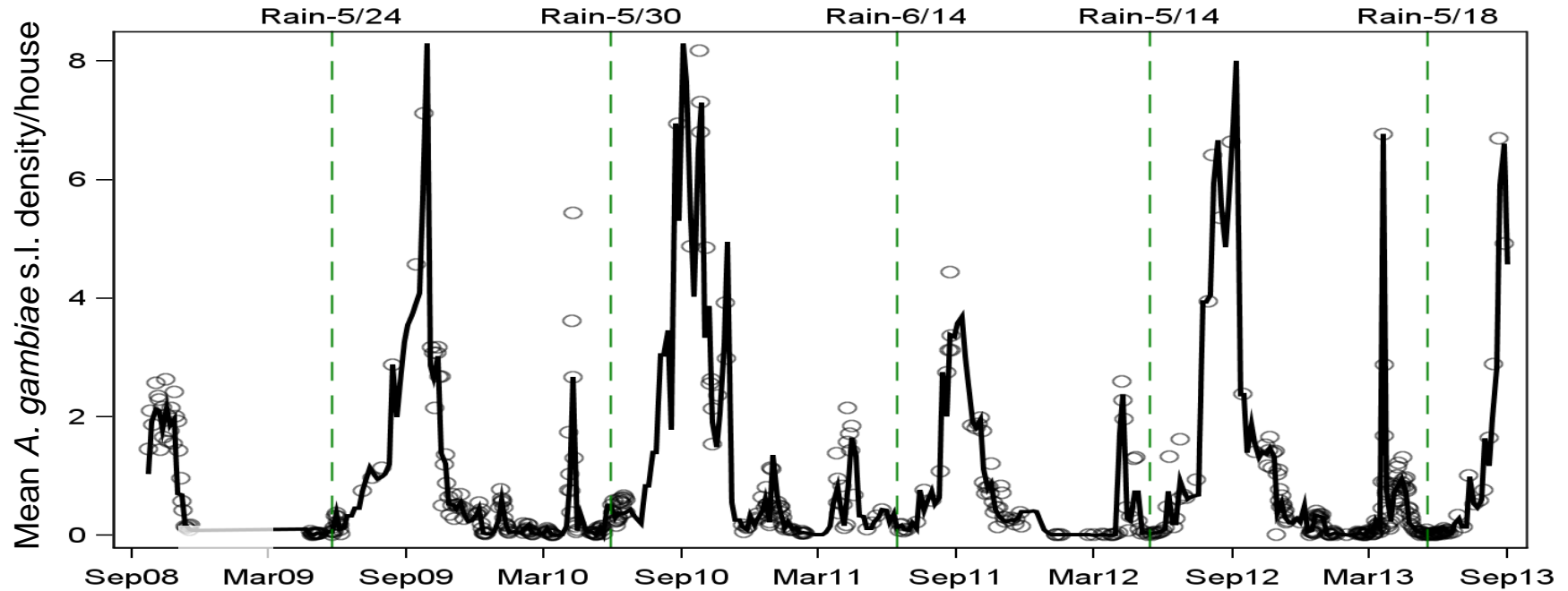
- An. farauti* s.l.;
- An. koliensis*;
- An. punctulatus* s.l.
- An. dirus* s.l.;
- An. minimus* s.l.
- An. lesteri*;
- An. sinensis*
- An. balabacensis*
- An. barbirostris* s.l.
- An. dirus* s.l.
- An. farauti* s.l.
- An. flavirostris*
- An. koliensis*
- An. lesteri*
- An. leucosphyrus/latens*
- An. maculatus*
- An. minimus* s.l.
- An. punctulatus* s.l.
- An. sinensis*
- An. sundaicus* s.l.

Annual Mosquito Entomological Inoculation Rate (EIR) and Proportion of Individuals Infected with *P. falciparum*



- decreasing EIR from 200 to 100 reduces infection prevalence by 4%
- decreasing EIR from 100 to 1 reduces infection prevalence from 70% to 30%

Wet-Dry Season Ecology of Malaria Mosquitoes

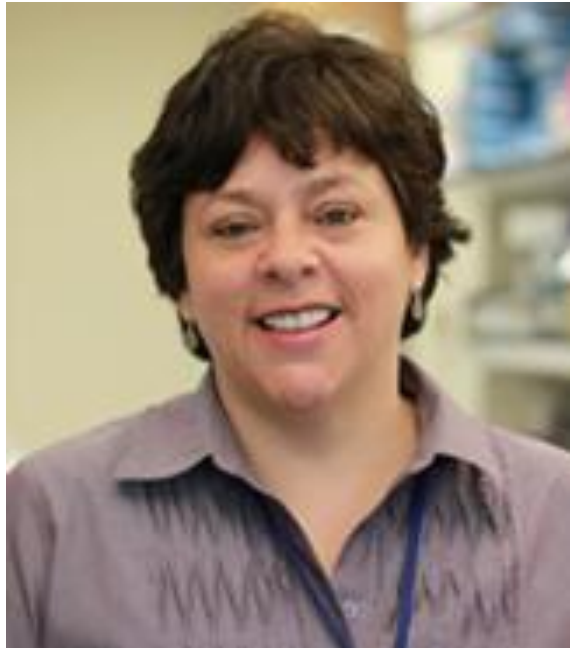


Wet Season (June – October)



Dry Season (November-May)

P. falciparum Can Suppress Midgut Nitration and Evade Mosquito Immunity

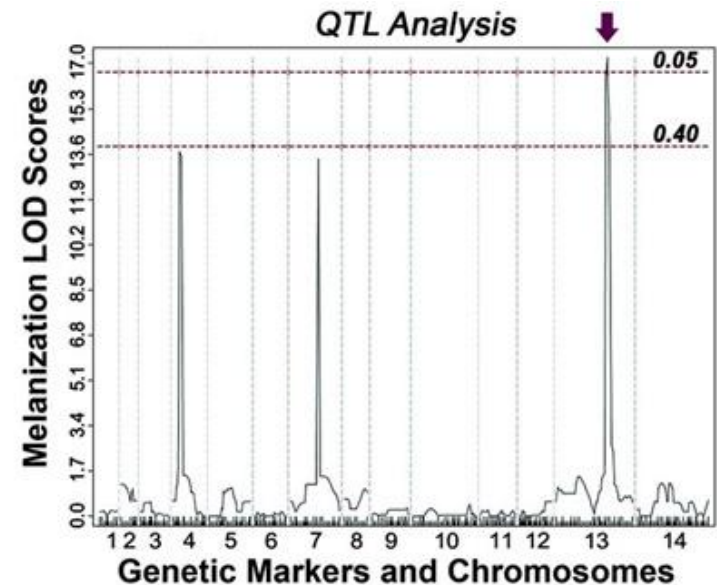
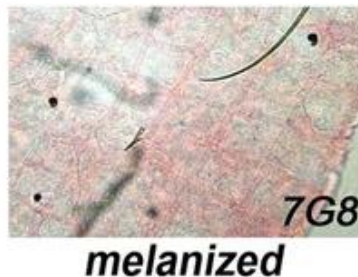


Carolina Barillas-Mury

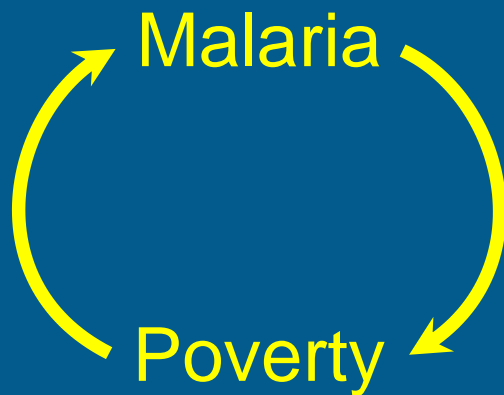
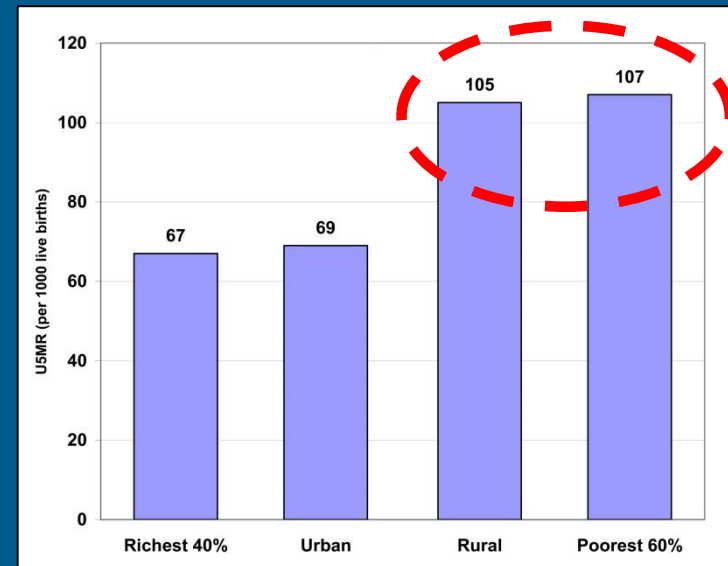
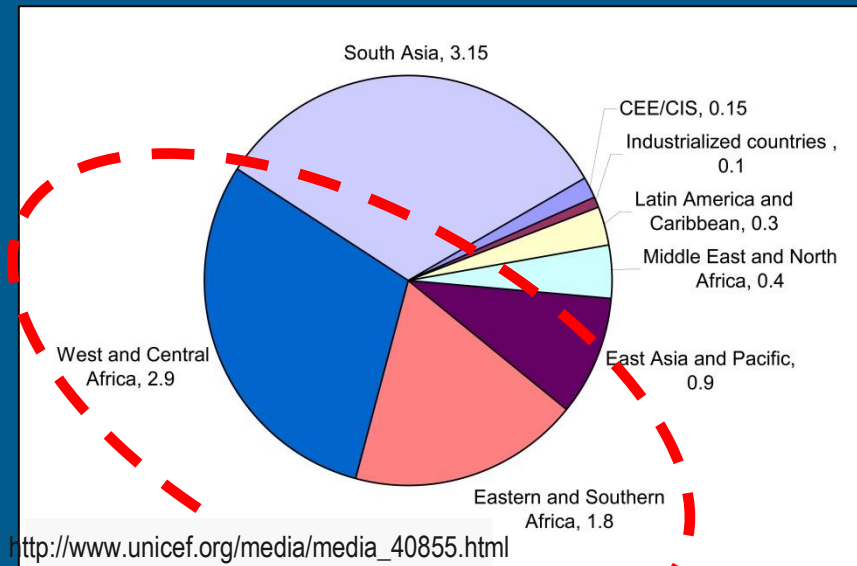
Science 24 May 2013:
Vol. 340 no. 6135 pp. 984-987
DOI: 10.1126/science.1235264

The Human Malaria Parasite *Pfs47* Gene Mediates Evasion of the Mosquito Immune System

Alvaro Molina-Cruz¹, Lindsey S. Garver¹, Amy Alabaster¹, Lois Bangiolo¹, Ashley Haile¹, Jared Winikor¹, Corrie Ortega¹, Ben C. L. van Schaijk², Robert W. Sauerwein², Emma Taylor-Salmon¹, Carolina Barillas-Mury^{1,*}



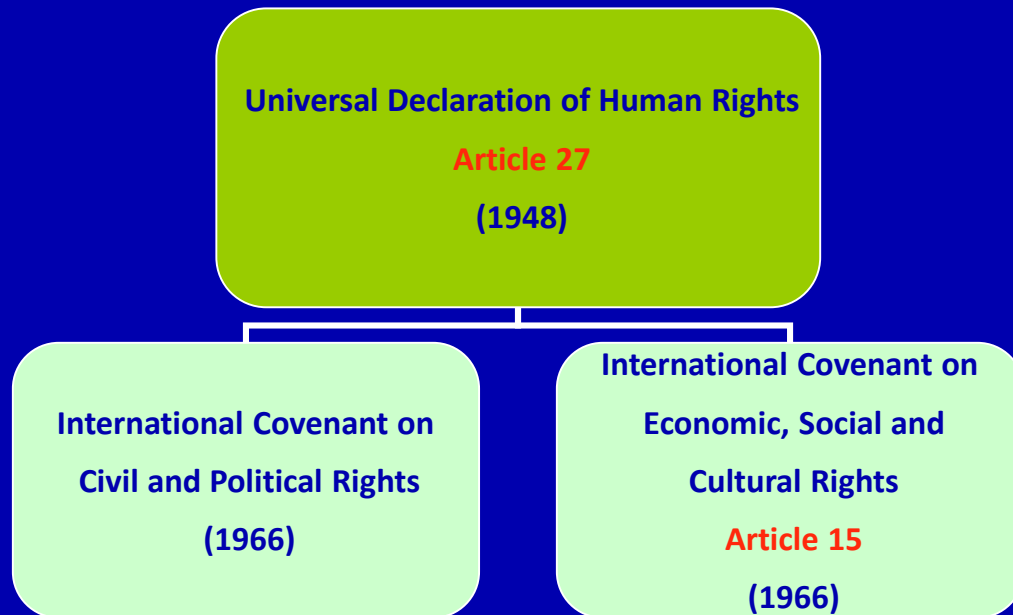
Distribution of Under-Five Child Mortality by Region & Income



“Men and women were sick because they were poor; they became poorer because they were sick and sicker because they were poorer”

Winslow (1951) *WHO Monograph Series No. 7*

International Bill of Rights



ICESCR commits parties to work toward economic, social, and cultural rights for individuals, including labor rights and the right to health, the right to education, and the right to an adequate standard of living.

Socioeconomic development as an intervention against malaria: a systematic review and meta-analysis

Lucy S Tusting, Barbara Willey, Henry Lucas, John Thompson, Hmooda T Kafy, Richard Smith, Steve W Lindsay

Summary

Background Future progress in tackling malaria mortality will probably be hampered by the development of resistance to drugs and insecticides and by the contraction of aid budgets. Historically, control was often achieved without malaria-specific interventions. Our aim was to assess whether socioeconomic development can contribute to malaria control.

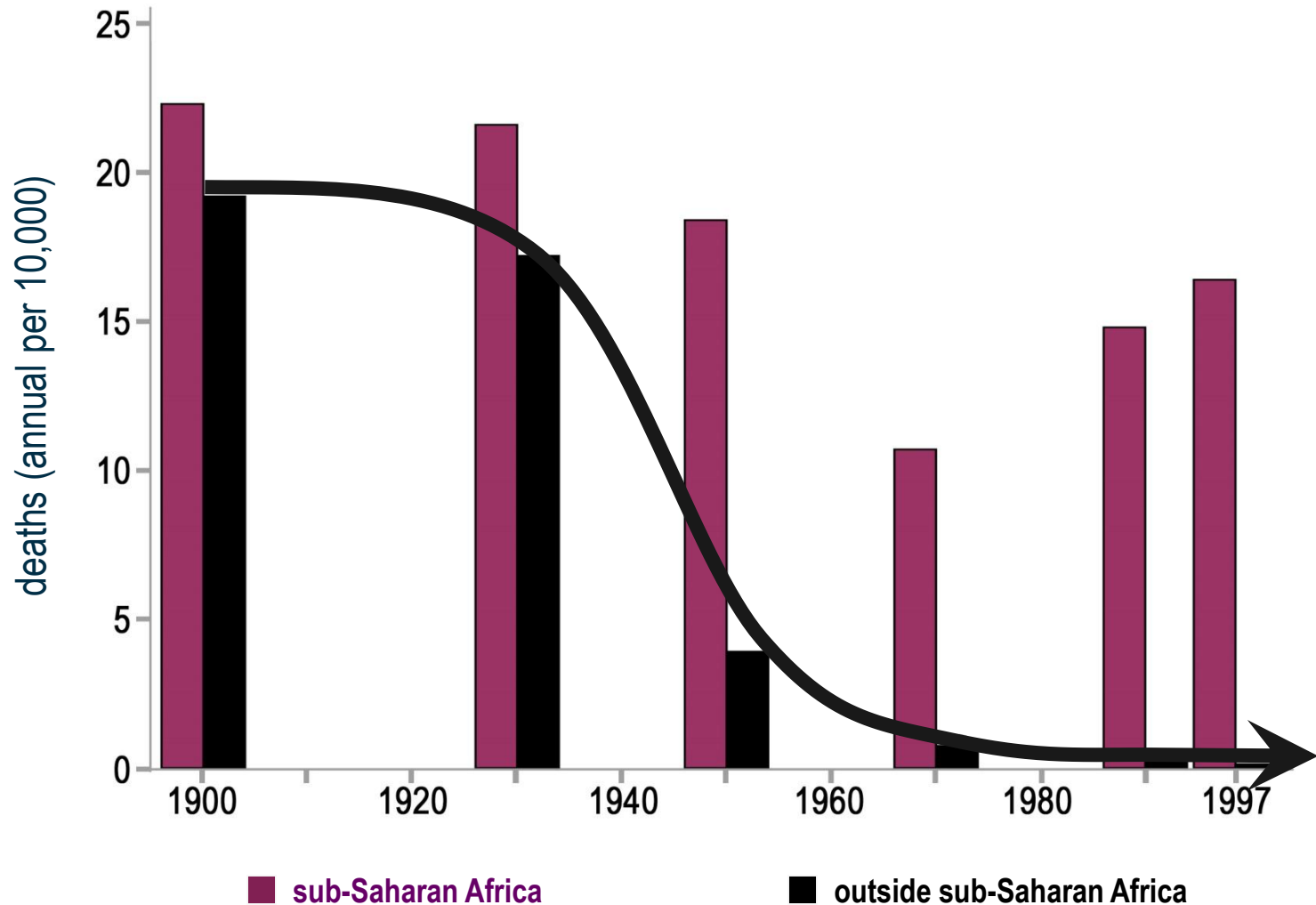
Methods We did a systematic review and meta-analysis to assess whether the risk of malaria in children aged 0–15 years is associated with socioeconomic status. We searched Medline, Web of Science, Embase, the Cochrane Database of Systematic Reviews, the Campbell Library, the Centre for Reviews and Dissemination, Health Systems Evidence, and the Evidence for Policy and Practice Information and Co-ordinating Centre evidence library for studies published in English between Jan 1, 1980, and July 12, 2011, that measured socioeconomic status and parasitologically confirmed malaria or clinical malaria in children. Unadjusted and adjusted effect estimates were combined in fixed-effects and random-effects meta-analyses, with a subgroup analysis for different measures of socioeconomic status. We used funnel plots and Egger's linear regression to test for publication bias.

Findings Of 4696 studies reviewed, 20 met the criteria for inclusion in the qualitative analysis, and 15 of these reported the necessary data for inclusion in the meta-analysis. The odds of malaria infection were higher in the poorest children than in the least poor children (unadjusted odds ratio [OR] 1·66, 95% CI 1·35–2·05, $p < 0·001$, $I^2 = 68\%$; adjusted OR 2·06, 1·42–2·97, $p < 0·001$, $I^2 = 63\%$), an effect that was consistent across subgroups.

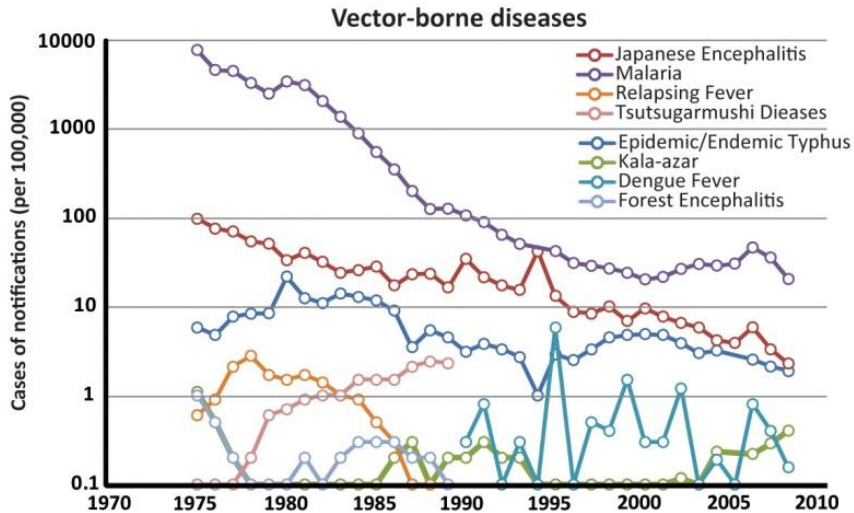
Interpretation Although we would not recommend discontinuation of existing malaria control efforts, we believe that increased investment in interventions to support socioeconomic development is warranted, since such interventions could prove highly effective and sustainable against malaria in the long term.

Funding UK Department for International Development.

Malaria Death Rates in the 20th Century



Control of Malaria in PR China

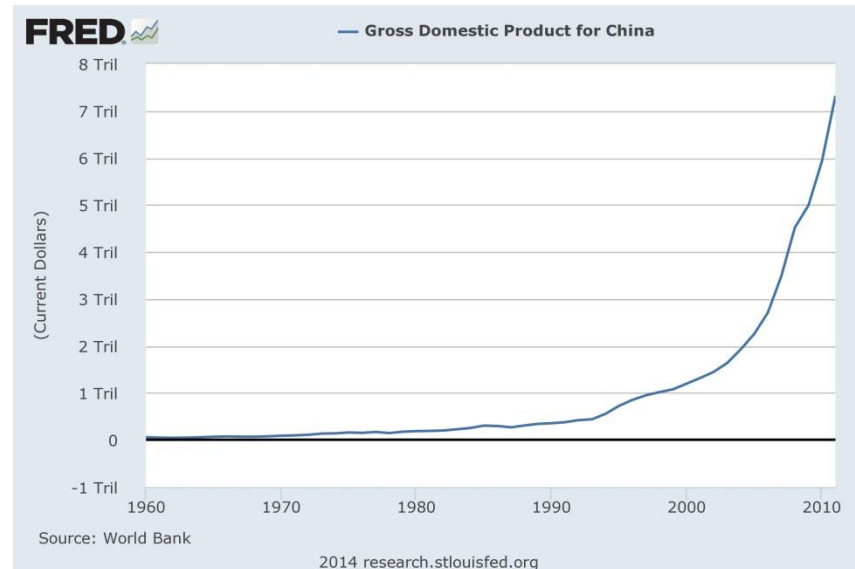


A Handbook of Prescriptions for Emergencies by Ge Hong (284–346 CE). (a) Ming dynasty version (1574 CE) of the handbook. (b) "A handful of qinghao immersed with 2 liters of water, wringing out the juice and drink it all" is printed in the fifth line from the right. (From volume 3.)



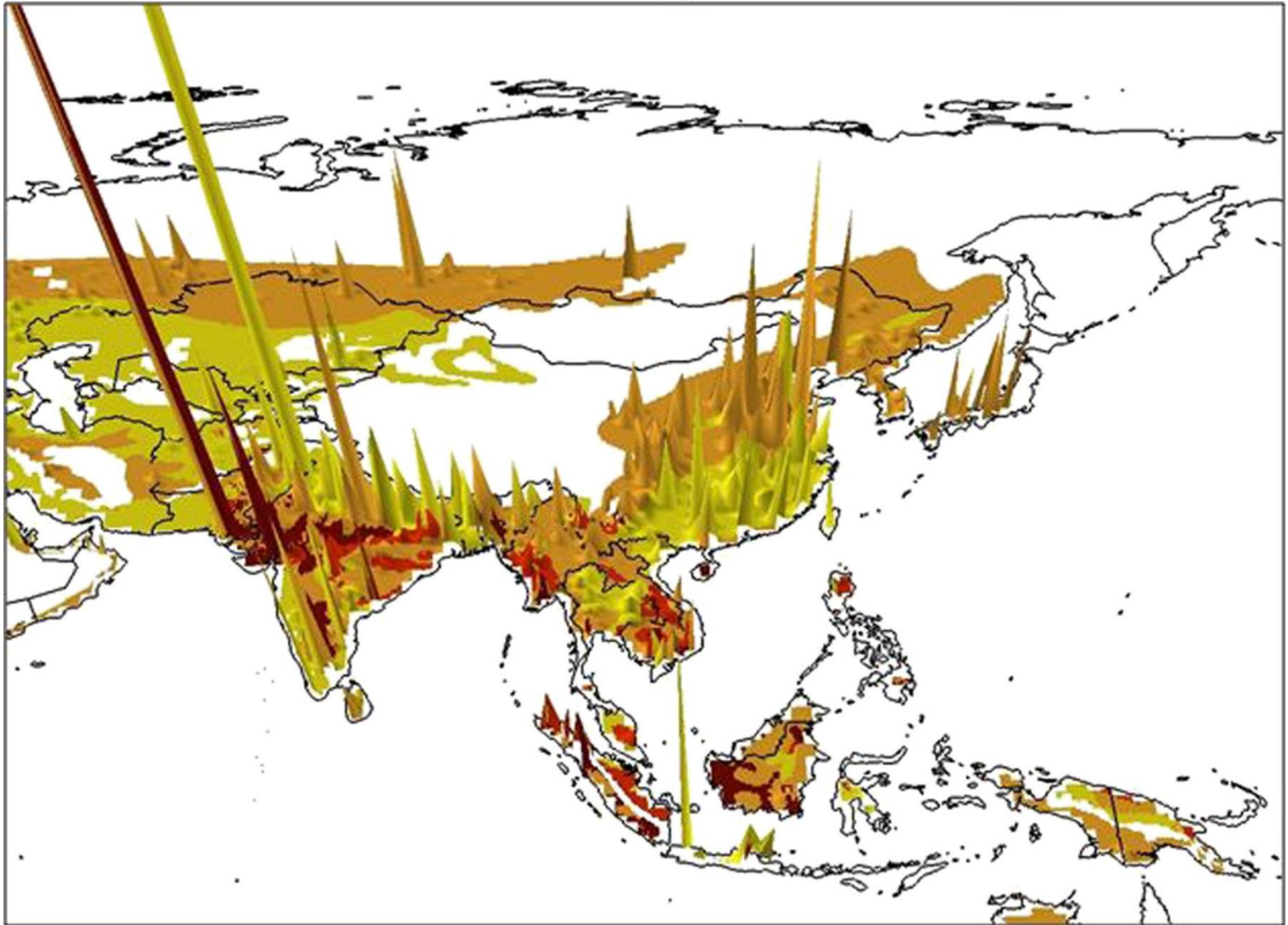
Youyou Tu, winner of the 2011 Lasker-DeBakey Clinical Medical Research Award

- Primary health care nets
- Community Participation
- Official commitment at all levels
- Integrated antimalarial measures
- Widely available microscopical stations and treatment
- Provincial and regional intersectorial programs
- Scientific research, drug discovery

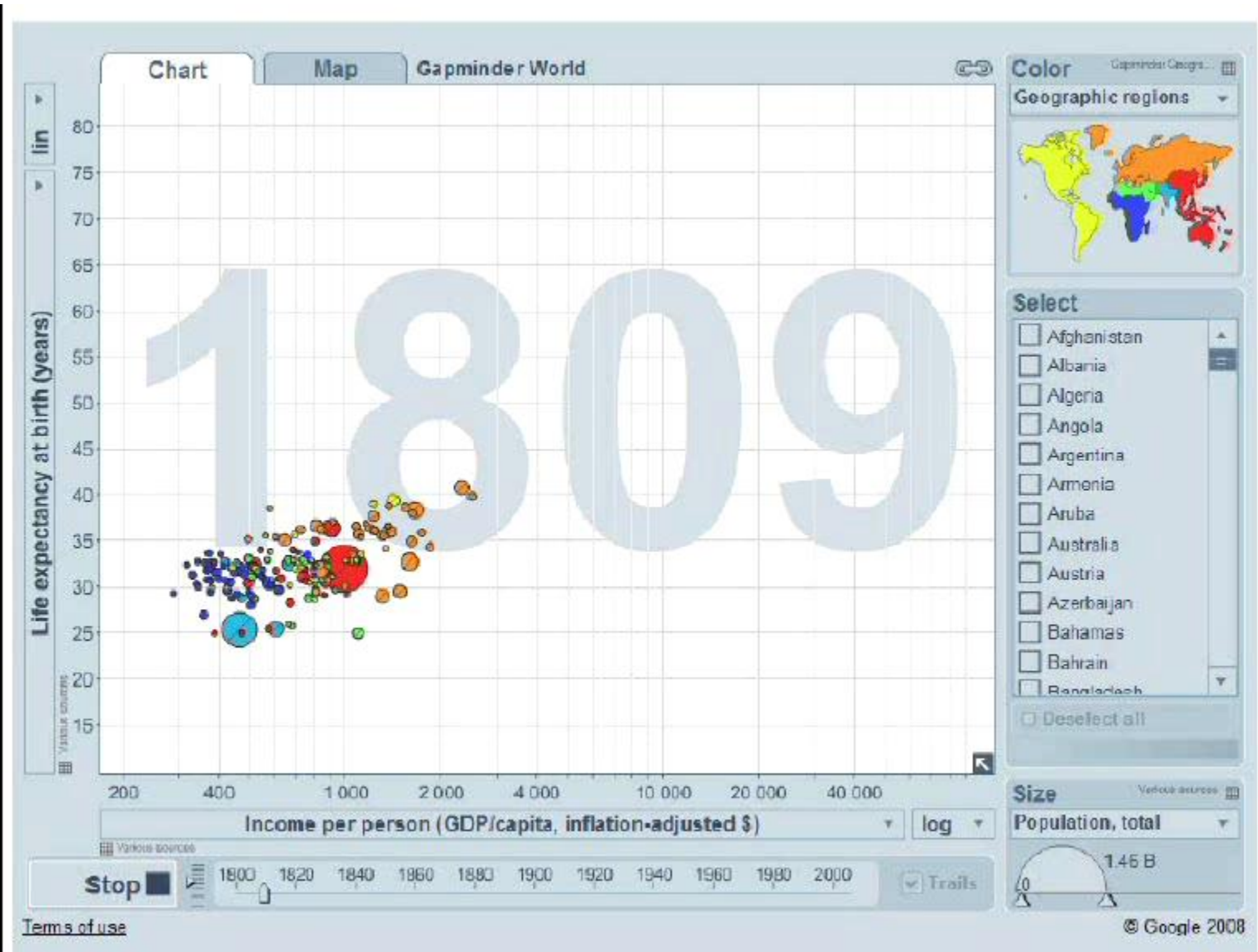


Tang *et al.* (1991) *Southeast Asian J.Trop.Med. Public Health* **22**: 467-476;
 Tang (2000) *Chin.Med.J.* **113**:89-92; Zhang & Wilson (2012) *PLoS One* **7**: e31076

Urbanization and the Global Decrease of Malaria Transmission



Tatem et al. (2013) *Malaria J.* **12**: 133; Qi et al. (2012) *Malaria J.* **11**: 403



Breaking the Health-Poverty Trap

MAKING MALARIA HISTORY Newsletter

Latest news

25 August 2014

MalariaCare hosts community case management webinar

20 August 2014

Mozzy myth busting on World Mosquito Day

12 August 2014

A new era for malaria treatment

11 August 2014

Private sector malaria investment in Senegal

30 July 2014

A business approach to malaria prevention

24 July 2014

On the road to "test and treat"—are we there yet?

16 July 2014

Report highlights maternal and newborn health

14 July 2014

Leveraging the power of sport to fight malaria

09 July 2014

Malaria pre-elimination in Senegal

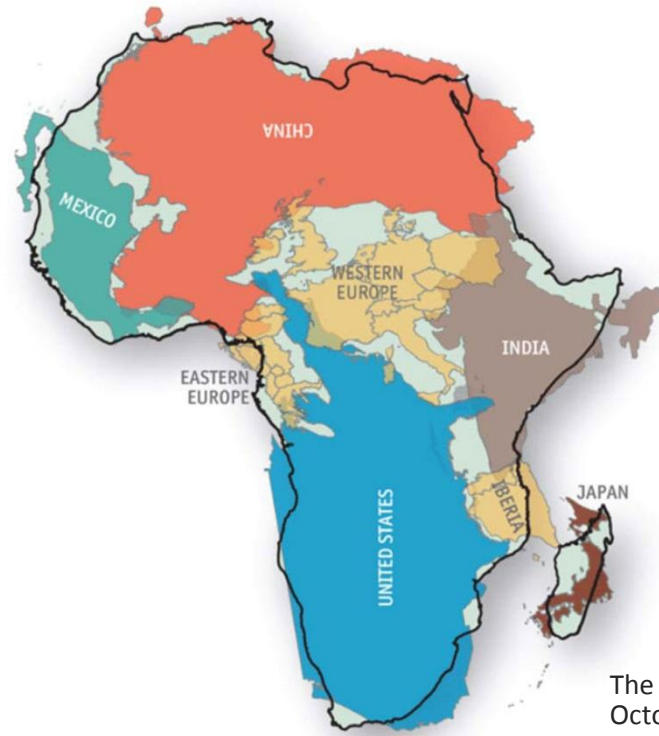
The benefits of investing in malaria



Malaria's impact on child health and broader national economic development is a profound one.

Malaria alone costs the African continent \$12 billion per year and is an economic drain on families, communities, and nations. But current investments are already shrinking the malaria map and improving the health and financial well-being of countries across the African continent. In fact, every \$1 invested in malaria prevention and treatment delivers a return of \$20.

MACEPA PATH
Malaria Control and Elimination Partnership in Africa



The Economist
October 20, 2012

THE WALL STREET JOURNAL =
AFRICA RISING

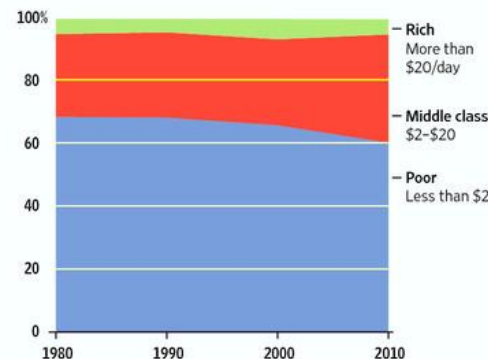
A New Class of Consumers Grows in Africa Market on Par With China's and India's

By PETER WONACOTT May 2, 2011

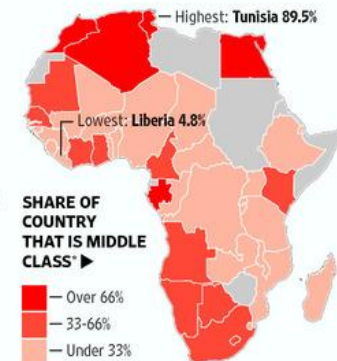
Buying In

Africa's middle class has risen to 34% of the population, expanding to 313 million people.

SHARE OF AFRICA'S
POPULATION,
BY CLASS ►



© Data not available for all countries; Source: African Development Bank Group



5 Reasons Why 2013 Was The Best Year In Human History

BY **ZACK BEAUCHAMP**  POSTED ON DECEMBER 11, 2013 AT 3:34 PM UPDATED: DECEMBER 12, 2013 AT 10:55 AM

Between the brutal civil war in Syria, the government shutdown and all of the deadly dysfunction it represents, the NSA spying revelations, and massive inequality, it'd be easy to for you to enter 2014 thinking the last year has been an awful one.

But you'd be wrong. We have every reason to believe that 2013 was, in fact, the best year on the planet for humankind.

- 1. Fewer people are dying young, and more are living longer.**
- 2. Fewer people suffer from extreme poverty, and the world is getting happier.**
- 3. War is becoming rarer and less deadly.**
- 4. Rates of murder and other violent crimes are in free-fall.**
- 5. There's less racism, sexism, and other forms of discrimination.**

